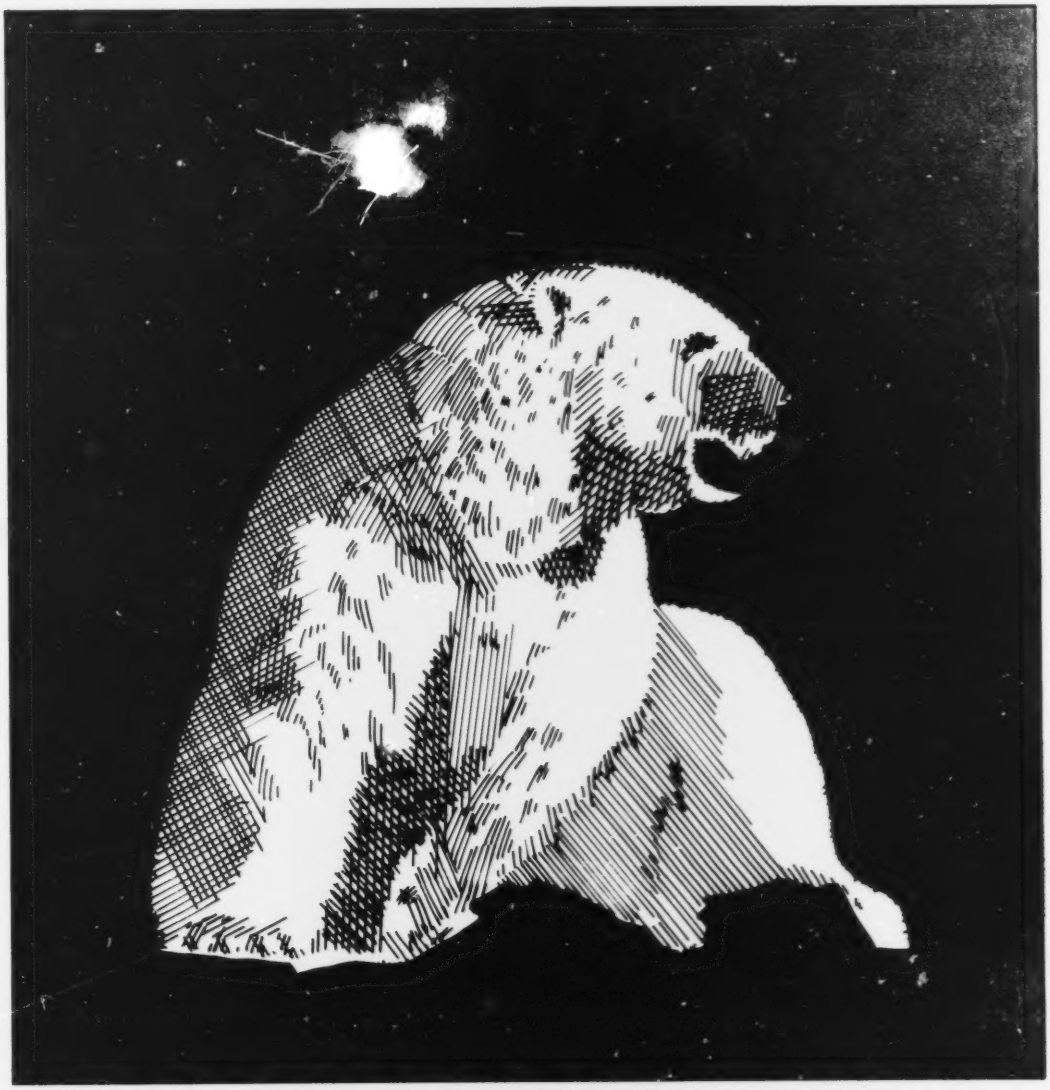
POLAR BEAR

Life History and Known Distribution of Polar Bear in the Northwest Territories up to 1981



Northwest Territories Renewable Resources
The Honourable Nellie Cournoyea, Minister

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Life History and Known Distribution of Polar Bear in the Northwest Territories up to 1981

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and

R. E. Schweinsburg

1984

Northwest Territories Renewable Resources

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Note to the Reader

Every year new information is received about polar bear numbers and distribution in the Northwest Territories. For recent developments and the most up-to-date information, contact the Northwest Territories Department of Renewable Resources in Yellowknife.

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INTRODUCTION

For millenia, the arctic seas have been annually congealing into a vast sheet of ice. Yet in all that time, the surface has become the home for only one creature. That the denizen of this frozen desert should be a bear is one of Nature's unfathomable pranks, for the entire family abhors winter. Thus the polar bear is a paradox: the colour a bear should not be, living where a bear should not live, doing what a bear should not do. The incongruity of this huge animal flourishing in the harsh Arctic continually fascinates all who contemplate its marvellous existence. As a symbol for the Northwest Territories – the land of ice and cold – there is no better choice than this animal which thrives by virtue of its strength, ingenuity and perseverance. In a place where magnificent wildlife species abound, the polar bear is pre-eminent – as much a lord of the Arctic as the lion is of Africa.

The many admirable, fearsome, and endearing qualities of the polar bear were well known to indigenous peoples, whose stories and myths featuring this animal are legion. From a practical standpoint, the polar bear provided some food and clothing but was not a central resource for human subsistence in pre-historic times. However, with the arrival of Europeans came the hide trade and, much later, sport hunting, so that the value of this species to arctic residents is much greater now than in the past.

Until recently, humans and polar bears pursued reciprocal lifestyles: humans killed some bears, bears killed some humans, and they both hunted for seals. Modern weaponry has tipped the balance and the polar bear escaped extinction only through worldwide efforts. Although no longer an endangered species, the polar bear's future is still precarious because of mounting industrialization in its habitat. Areas in the Arctic likely to be affected by resource development and its related activities are shown in Figure 1. If past lessons are heeded, and conservation ethics are sincerely maintained through responsible management, the status of polar bears need never be jeopardized again.

The key role in this endeavour must be taken by the Northwest Territories, which currently supports about three-quarters of the world's remaining polar bear population.

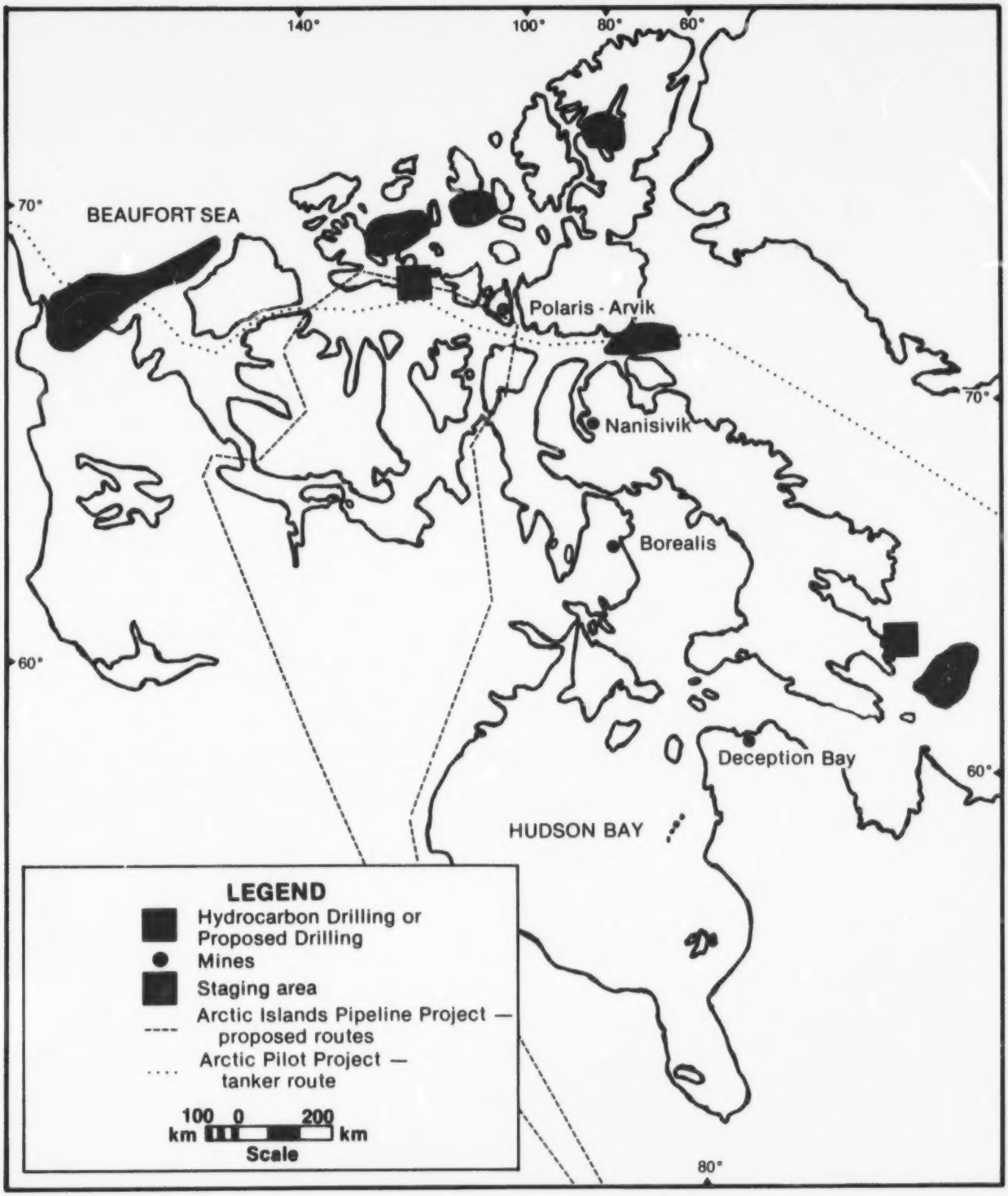


Figure 1. Current and proposed industrial activity in the Arctic.

LIFE HISTORY

Taxonomy

The polar bear (*Ursus maritimus*) belongs to the family Ursidae, order Carnivora. Its behavioural and physical dissimilarities from other bears confused taxonomists for some time, and it was placed in the separate genus *Thalarctos* (Burton 1962). However, it is now known from comparisons of blood proteins that black, brown, and polar bears are closely related, the best evidence being the production of fertile offspring from cross-specific matings in zoos (Larsen 1978). Therefore, the polar bear is now classified in the same genus (*Ursus*) as the others. Its specific name (*maritimus*) describes it as a maritime animal. Since a separate fossil form, *Ursus maritimus tyrannus*, has been described, the existing race of polar bears has been designated as *Ursus maritimus maritimus* (Manning 1971).

During the Pleistocene, in Europe, the polar bear evolved from its progenitor, *Ursus etruscus*, and later radiated into North America. At present just one circumpolar race is recognized, but the increase in skull sizes from east Greenland across to southern Alaska is such that skulls from the former are morphologically distinct from those of the latter area. The ones in between (north Alaska and Canada) are not significantly different from the Greenland type (Manning 1971). It has also been suggested that the south Alaska bears may be descended from a population which became isolated for a period of about 7000 years during the Wisconsin glaciation, and therefore should be accorded separate subspecific status (Manning 1971).

Description

The polar bear is the largest land carnivore in the world, its only contender being the Alaskan brown bear (*Ursus arctos*) (Larsen 1978). In Canada, adult male polar bears weigh between 450 and 635 kg (1000-1400 lb) and in Alaska they may reach 700 kg (1540 lb) or more. Adult females weigh from 180 to 300 kg (400-650 lb) (Larsen 1978). Male bears measure between 2 and 3 m (7-11 ft) in length and are about 120 cm (4 ft) high at the shoulder (Banfield 1974).

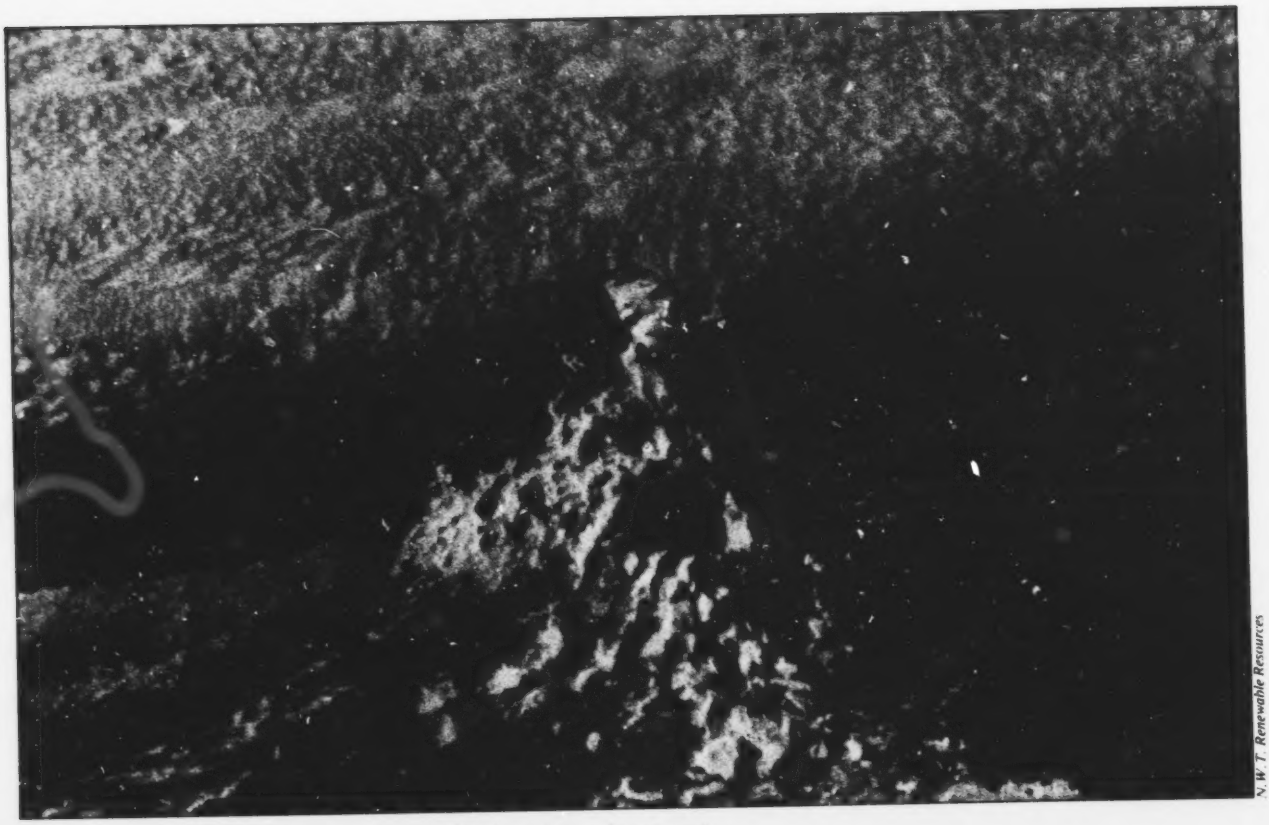
Colour may range from the pure white of the new coat in summer to creamy yellow or golden in late winter and spring. The annual moult occurs between May and August. The guard hairs are glossy and stiff compared to other bears and the underfur is extremely dense (Larsen 1978). As well as being insulative, the hair transmits ultraviolet light to the dark skin, thereby providing additional warmth. Other adaptations for heat conservation are small ears, hair-covered foot pads, and a thick layer of subcutaneous fat. Primarily a carnivore, the polar bear possesses prominent canines, edged cheek teeth, and sharp, grasping claws 7-13 cm long. Its conformation is more streamlined than that of other bears because of its elongated neck and skull, plus a smooth facial profile created by a reduced brow ridge and an arched muzzle. However, like its relatives, this species also has a black nose and brown eyes.

Behaviour

Polar bears are neither solitary nor gregarious but socialize to varying degrees depending upon season and circumstance. During winter, bears spend much of their time alone, but even then may seek out others. In summer, they often become concentrated because of habitat limitations, and at any time a number of bears may gather to capitalize on a windfall such as a beached whale carcass. Interactions on such occasions usually include aggressive displays or a considerable amount of ritualized physical contact (Latour 1980). Under certain conditions, cannibalism occurs, due in part to the confinement of some summer retreats (Russel 1975). Generally congregations of polar bears, except during the breeding season, exhibit considerable tolerance among individuals. However, family groups, consisting of a mother and her young, avoid conspecific contact whenever possible.

Polar bears are promiscuous and mating involves ferocious competitions between males that can cause injuries and occasional fatalities (Larsen 1978). Male bears accompany females in oestrus for days or weeks, and the pairs may mate a number of times during their association before finding other mates (Larsen 1978).

Pregnant females excavate maternity dens in snowdrifts around early November, and most of them emerge with their cubs in March or April (Larsen 1978). While in the den the female is dormant, not hibernating, which means that she can be awakened at any time. There is potential for disturbance by industry during this crucial period. For instance, a crew operating a bulldozer observed a mother removing her cubs from an occupied maternity den, presumably in response to the disturbance of their machine (Slaney



N.W.T. Renewable Resources

Dens are often made in south facing, deep snow drifts, located near the sea coast.

and Co. Ltd. 1974).

Bears, other than pregnant females, may occupy winter dens either on land or ice for a few days at a time, to escape inclement weather (Larsen 1978). Where snow conditions are suitable, summer dens or pits may be used (Schweinsburg 1979), possibly to reduce body heat and/or to conserve energy during periods of food shortage. The occupants of such excavations seem to be more alert than those in winter dens (Schweinsburg 1979), and perhaps more vulnerable to disturbance. In snowless summer retreats, earth pits are used instead (Russel 1975, Larsen 1978).

Polar bears are swift, agile, ingenious, and powerful predators. In a study of predation on the sea ice (Stirling and Archibald 1977), 77% of the observed hunts were still-hunts, in which bears waited by breathing holes and struck at emerging seals. The remaining 23% of the hunts involved stalking either by creeping along the ice or swimming to the edge of ice floes; both approaches end in a last minute rush at the prey. In the James Bay islands, bears hunt waterfowl on the open sea by swimming underwater and grabbing the birds from beneath (Russel 1975). They catch seals in open water by lying motionless on the surface and awaiting the approach of prey (Furnell and Oolooyuk 1980), which incautiously mistake the bear's shape for a small ice floe. Bears will kill, with relative impunity, any animal that can be overcome, such as narwhal, walrus calves, and even muskoxen stranded in deep drifts (Larsen 1978).

Occasionally they attack humans without provocation, although it is believed a bear must be very hungry or inexperienced to do so (Northwest Territories Wildlife Service files).

Polar bears are adept swimmers, employing their proficiency and stamina for hunting, gathering kelp from the sea bottom (Russel 1975), and possibly collecting marine invertebrates. Bears flee towards open water, and will often swim long distances when necessary. They prefer short-term immersions, such as they undergo while travelling across the broken ice. Polar bears cannot swim indefinitely and will perish from exhaustion if they do not eventually reach land or ice.

Polar bears have no instinctive fear of humans, but those which have previously been hunted will usually flee from snowmobiles, although not necessarily from humans per se. The reactions of polar bears toward dogs are ambivalent. Consequently, dogs are not sure protection for lives or property. In experiments at Churchill, polar bears readily habituated to an assortment of unnatural or annoying, physical, and chemical stimula (intended as deterrents). Such behaviour indicates that this species is highly adaptable and imperturbable once an attractant, such as garbage, is perceived (Northwest Territories Wildlife Service files).

Food Habits

Seals constitute more than 90% of the polar bear's winter diet (Larsen 1978), with the ringed seal (*Phoca hispida*) and bearded seal (*Erignathus barbatus*) being the major prey (Stirling et al. 1980). Others taken to a much lesser extent are: harp seals (*Pagophilus groenlandicus*), hooded seals (*Cystophora cristata*) (Larsen 1978), and harbour seals (*Phoca vitulina*). It is estimated that over an eight month winter period each bear in Hudson Bay consumes an average of 4 kg (8.8 lb) of seal per day (Larsen 1978).

Summer diets vary regionally with the availability of particular food items. On the James Bay islands about 70% of the diet consists of sea birds which are caught by bears in open water. Reports from other areas suggest that where local conditions permit (e.g. turbid water and an abundance of waterfowl), birds also predominate as a summer food source (Russel 1975). Where ice cover persists, such as in deep bays or particular channels, polar bears concentrate on seals (Stirling et al. 1978). Some bears can also catch them in open water (Furnell and Oolooyuk 1980). On the Manitoba coast, Russell (1975) observed the major component of the polar bear's summer diet to be other polar bears. Bears which summer inland from Hudson Bay tend to utilize roots, grass, berries and rodents (Larsen 1978). Marine invertebrates were common in the scats of bears summering in Hudson and James Bays. In that area and in the High Arctic as well, marine algae are a regular constituent of the summer diet (Russel 1975).

In general, bears will eat any animal they can kill. In addition to the aforementioned special diets, the list of occasional prey species includes: geese (Larsen 1978), beluga, fish, mussels, crabs, starfish (Banfield 1974), microtine rodents, tunicates (Russel 1975), plus the eggs and young of waterfowl and cliff-dwelling birds (Banfield 1974). There are also rare cases in which humans have been eaten by polar bears (Northwest Territories Wildlife Service files). The carrion of any animal is attractive to bears, and at times congregations of up to 40 bears have been attracted by a bowhead whale carcass (Larsen 1978). A variety of vegetable matter is also consumed by bears, either incidentally or intentionally in large volumes. As well as the plants previously mentioned, the polar bear's diet may include mosses, grasses, and the leaves and stems of shrubs and broad-leaved herbs (Russel 1975).

Polar bears scavenge from settlement dumps, caches, and camps. An unfortunate characteristic of this species is that it will ingest foods heavily contaminated by petrochemicals such as diesel fuel, or may even consume quantities of pure petroleum products such as engine oil and grease. Another problem concerning environmental contamination is that bears are at the end of marine food chains which progressively concentrate chemical pollutants. Thus, polar bears could accumulate toxic chemicals which might lead to the death of some individuals and ultimately to a population decline. So far, little is known about this aspect of polar bear ecology, although industrial activity in the arctic seas is steadily increasing and pollution is being received from southern regions via ocean and air currents.

Habitats

The habitat requirements of polar bears vary seasonally and with the sex and reproductive status of individuals. Three major habitat types are important to this species and a fourth has been suggested. They are:

(1) **Feeding areas.** During winter, bears throughout the Arctic hunt on the sea ice and therefore principal habitat requirements are related to seal abundance and accessibility. In the eastern Beaufort Sea, ice types in order of importance to polar bears are (Stirling et al. 1975):

   (i) **active ice habitat**, where leads are continually forming and refreezing, and the ice is bare or slightly drifted;

   (ii) **floe edge habitat**, where leads are wide and often accompanied by small, open or refrozen leads and some pressure ridges;

   (iii) **stable flat ice habitat**, interspersed with stationary pressure ridges that are drifted over and suitable for seal lairs.

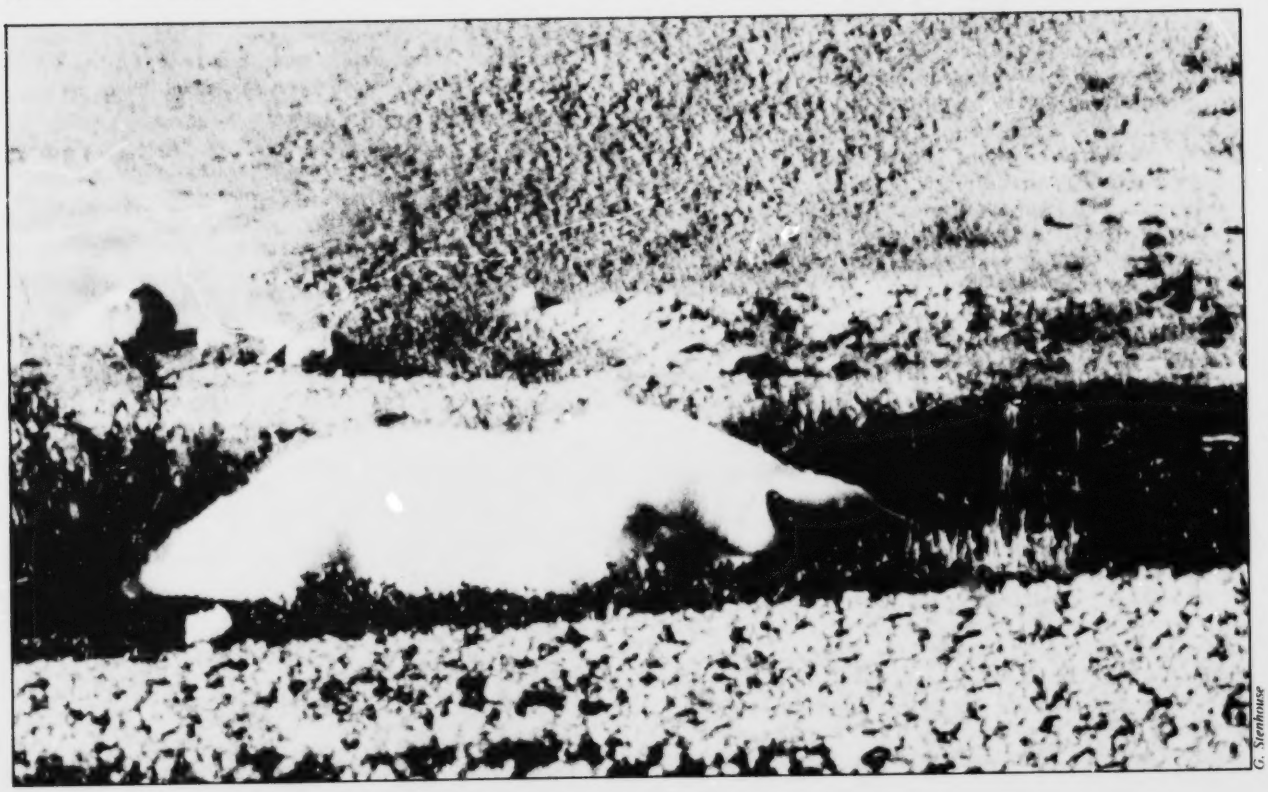
Active ice zones, particularly those associated with small islands, are preferred winter habitat wherever they occur in the Canadian Arctic. The floe edge is also an important winter feeding area. Where neither of those ice types is available, bears may seek rough ice which is drifted over sufficiently to provide lairs for seals (Schweinsburg et al. 1981).
Polynyas are considered to be important winter feeding areas for bears (Stirling 1980) since they often attract and maintain seal populations.

The only polar bears whose requirements differ from the aforementioned winter habitats are family groups with newborn cubs which seem to avoid such areas, probably to minimize predation by adult males. Their habitat requirement is an absence of other bears. They tend to frequent land-fast ice, keeping to areas where ice conditions may be less favourable for seal hunting until the cubs are mobile enough to avoid larger bears.

As break-up proceeds, the locations of early summer feeding areas often differ from winter ones. The edge of land-fast ice may become an important early summer feeding area (Stirling et al. 1980) after the pack ice has dissolved; but local ice conditions may also provide other types of feeding areas, such as ice-covered channels (Schweinsburg et al. 1981), large ice floes, and ice islands.

During summer, the place where bears spend the period between break-up and freeze-up is probably not governed by food availability, but by other requirements (see Summer Retreats) (Stirling and Archibald 1977). Although polar bears can successfully capture seals in open water, summer feeding areas with ice cover seem to be preferred, though not imperative. In the Central and High Arctic, bears tend to congregate in deep bays during summer where ice cover persists (Stirling et al. 1978). Their main reason for doing so is unknown (Schweinsburg et al. 1980) although a preference for hunting from ice could be a factor.

(2) **Maternity denning areas.** In Canada, all maternity dens discovered have been found on land, but it is possible that in certain regions, such as the Beaufort Sea, some maternity denning may occur on the ice (Lentfer 1975). In general the prime denning requisite is land topography which promotes the formation of snow drifts deep enough for denning (Harington 1968). Such areas are



C. Stenhouse

To avoid overheating, polar bears are relatively inactive during the summer months.

preferably on or near the sea coast, although inland denning areas are also known (Stirling et al. 1977). Other features of suitable maternity denning habitats are (Harington 1968):

(i) **snow density:** Extremely hard or soft snow is unsuitable for denning.

(ii) **southern exposure:** Dens frequently occur on south facing slopes where drifts are usually deepest (because of prevailing northerly winds), windchill is least, and insolation (received solar energy) is greatest.

(iii) **slope angle and elevation:** These features vary considerably with topography. Angles of snow slopes in which dens are located vary from 20 to 70 degrees, and elevations of den sites vary from nearly sea level to 1700 m.

For most polar bear populations in Canada there is an abundance of suitable maternity denning habitats. Nevertheless, maternity denning may be concentrated in "core areas" because of geographical limitations (Spencer and Schweinsburg 1979), ice conditions and seal abundance (Schweinsburg et al. 1977).

Prior to hunting regulations that protect denning bears, another factor in the selection (or survival) of maternity denning areas may have been their remoteness from the traditional hunting grounds of Inuit and whalers (Stirling et al. 1975). A future requirement for suitable maternity denning habitats may be freedom from disturbance by industrial activities.

(3) **Summer retreats.** Most bears spend the summer near the sea, either on offshore islands or along sea coasts. Occasionally ice conditions may permit some bears to remain on multiyear ice or large ice floes (Schweinsburg 1980). The importance of areas which regularly conserve ice the longest is demonstrated by the consistent seasonal fidelity of sub-populations to such places (Schweinsburg et al. 1981).

A major problem for polar bears during summer is overheating. Thus, factors which afford relief from summer temperatures may strongly influence habitat selection. In Hudson and James Bays, adult male bears on the mainland coast frequent capes, headlands, and promontories, presumably for the cooling effect of offshore breezes (Stirling et al. 1977b). Indented coastlines are preferred summer habitats for many bear populations (Stirling et al. 1978, Schweinsburg et al. 1981), apparently because deep bays remain ice covered longer. Summer snow dens are used by bears in some places (Schweinsburg 1979) to escape heat or to conserve energy during the summer period of food scarcity. Earth pits are excavated in summer by some bears in Hudson and James Bays, also as a means of reducing body heat.

As in other seasons, family groups avoid male bears and thus their major requirement for summer retreats may be the absence of other bears. In Hudson and James Bays the summer retreats of family groups are inland, away from the coasts which male bears occupy (Stirling et al. 1977b). Selection of summer retreats may be determined by comfort, or other factors such as the patterns of break-up and freeze-up. Bears come ashore where break-up is latest or where ice floes deposit them (Harington 1968, Stirling et al. 1977b, Jonkel et al. 1976). If freeze-up begins first at some distant location, bears will move there during the course of the summer in order to reoccupy the sea ice as soon as possible (Stirling et al. 1977b). Thus, some summer retreats are large, whereas others may be quite small, either because late break-up and early freeze-up coincide (Stirling et al. 1978), or because bears are confined to small islands (Jonkel et al. 1976).

The relative importance of food availability in the selection of summer retreats is unknown. Probably this factor becomes influential only after the general area has been occupied on the basis of some of the aforementioned aspects. The wide range of summer food used by bears, and the variation in the methods of feeding which they have developed, suggest that in most cases they have adapted to the food resources of the habitat.

(4) **Breeding areas.** Breeding areas have not been studied as distinct polar bear habitat. However, it appears that mating may involve the use of particular land and ice formations such as headlands, ice islands, and pressure ridges, as scent posts, look-outs, and congregation sites. Such places are usually elevated from the surrounding landscape, and may be readily noticed by bears. Although fidelity to certain areas during spring is common among polar bear populations, it is most likely that such locations are primarily feeding areas wherein certain ice and topographical features are associated with breeding.

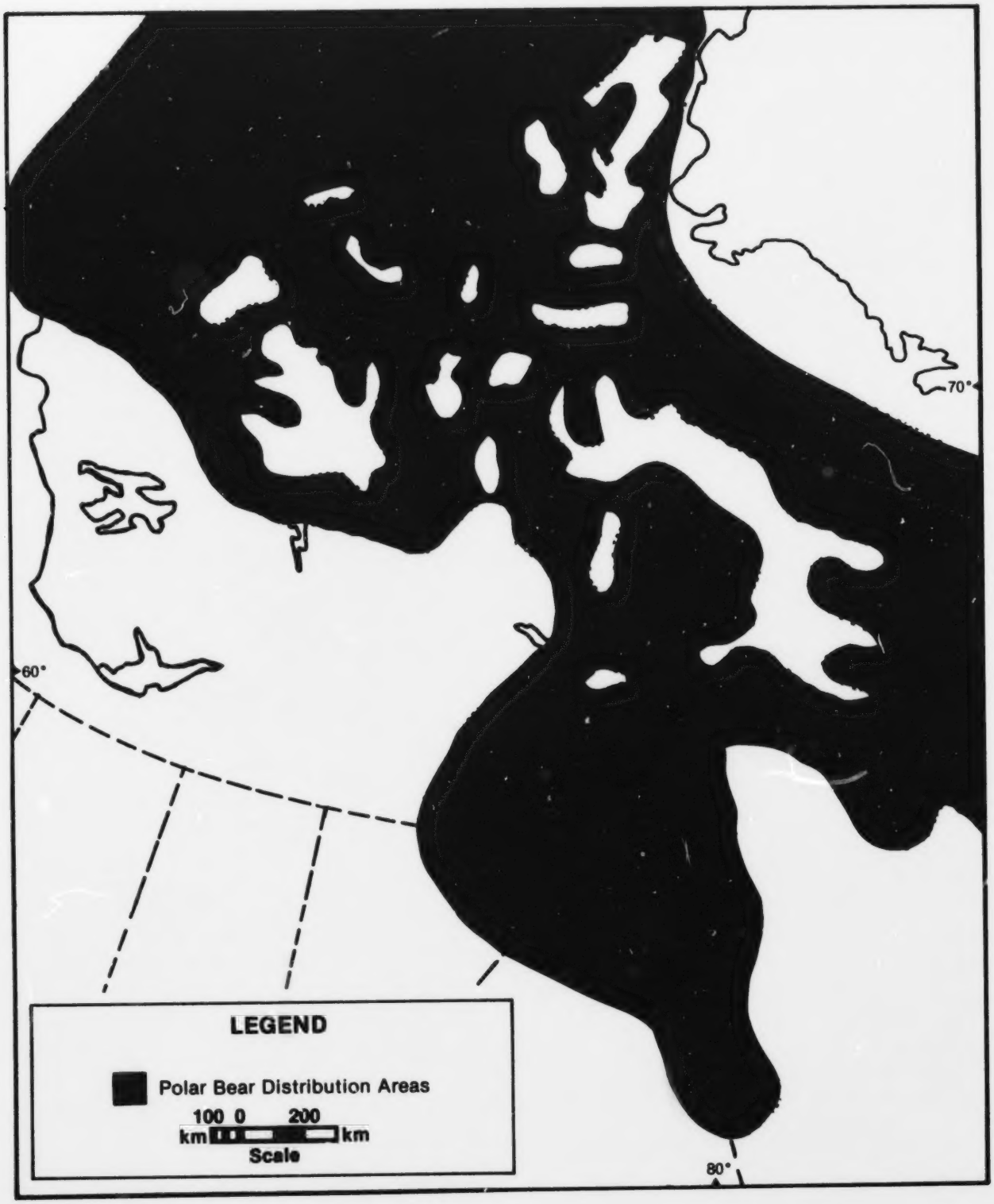


Figure 2. Polar bear distribution in Canada.

Distribution

Polar bears are distributed throughout the maritime regions of arctic Canada (Fig. 2). Their range extends from the pack ice of the Arctic Ocean to the southern coast of James Bay (Stirling et al. 1978), and from the North Atlantic to the Beaufort Sea (Stirling et al. 1975). Unlike many arctic marine mammals, the distribution of this species has not diminished appreciably within recorded history, except for a northward retraction from the coasts of Newfoundland and southern Labrador (Smith et al. 1975).

On a broad scale, polar bears are quite evenly distributed over most of their Canadian range, with a probable subaverage density in the northwest (Zone G) (Schweinsburg et al. 1977, Russel pers. comm., Parker pers. comm., Martin pers. comm.), and a definite scarcity in the southeast (Zone B) (Stirling and Kiliaan 1980). Within each zone, distribution is far from uniform, following a seasonal cycle of shifting concentrations from sea coasts and offshore islands in summer, to the sea ice in winter. There are several regional variations in this general pattern, usually governed by particular ice conditions and/or seal distribution.

For some time it was commonly believed that polar bears were nomadic, wandering extensively throughout the species' entire range and thus comprising a unified circumpolar population. However, it is now known that most bears occupy distinct home ranges, which tagging data indicates average between 150 and 300 km in diameter in Canada (Schweinsburg et al. 1980, 1981; Stirling 1978b). The clumped arrangement of overlapping home ranges forms a composite of localized sub-populations (Stirling et al. 1978), each having limited contact with its nearest neighbours and almost none with more remote ones. In Canada there may be as many as 10-15 such sub-populations although so far only nine can be identified with any certainty. Interacting sub-populations are defined as discrete populations that possess the same boundaries as those of the polar bear management zones. Many of the sub-populations are entirely confined to the Northwest Territories, while the remainder are shared with Manitoba and Ontario (Stirling et al. 1977b), Newfoundland (Smith et al. 1975), Quebec (Jonkel et al. 1976) and the Yukon (Stirling et al. 1975), as well as Alaska and Greenland (Stirling et al. 1980).

Abundance

The world population of polar bears is presumed to be in the neighbourhood of 20,000 animals (Larsen 1978), but this figure is no more than a rough compilation of estimates from the various countries involved. Attempts have been made to census most of the Canadian population (Table 1) but the results could be minimal because, in most cases, the offshore contingents are inaccessible. Thus the figures could represent only bears on the coast in parts of each zone during late winter when the samples were taken. The sum of those estimates is about 6400 animals (Table 1). From subjective evaluations of habitat quality and quantity in each zone, a conservative estimate for the unsampled coastal areas is about 4600 animals. This brings the total population of the Canadian coast to approximately 11,000 bears, unless the

Table 1. Estimated number of polar bears in each management zone of Canada.

Zone	Computed estimate	Subjective estimate	Area	Year
A[1]	1075		Churchill	1975
A[2]	—	(300)	entire zone	1980
A[3]	374		James Bay	1973
B	75 (60-90)		northern Labrador	1976-79
C	—	(2000)	entire zone	1980
D	700+		southeastern Baffin Island	1979
		(700)	remainder of zone	
E	1100		total excluding Hadley Bay	1979
F	1647		76% of the zone	1980
		(600)	remainder of zone	1980
G	—	(1000)	entire zone	1980
H	1435		entire zone	1978
Total	6406	+ (4600)	= 11,006*	

* Separate estimate based on a maximum sustained yield of 5% = 14,000

Most young accompany their mothers for two and a half years.

populations of the coast and offshore become completely mixed between samples. In that event, the entire Canadian population would be near 11,000. Another method of determining population size is based on statistical simulations of population dynamics which indicate that the maximum sustained yield of this species where family groups are protected is around 5% or less of the total population. Since the Canadian harvest of 700+ bears (600+ Northwest Territories, 100+ elsewhere) is believed to be nearing that limit, the total population should be about 14,000 bears. Given the host of possible errors in each estimating technique, the most prudent course is to assess the total Canadian population at 10,000-15,000 polar bears.

Reproduction

Polar bears are polygamous. Males compete for the attention of females in oestrus and each may breed with more than one in the same season. The mating period extends from late March to early June, but regardless of the conception date, the egg does not implant until September. It will only implant if the female has adequate fat reserves to live on during denning.

In captivity, cubs have been born from late November to January (Harington 1968), and presumably a similar variation exists in the wild with parturition occurring latest in the higher latitudes.

At birth, cubs are blind and weigh about 0.6 kg (19 oz) (DeMaster and Stirling 1981) but by the time they leave the maternity den their weight is near 9 kg (20 lbs) (Stirling and Jonkel 1972). Normally a female has two cubs but often one and sometimes three are born (Larsen 1978). Most young accompany their mothers for two and a half years but some may remain another year or two (Stirling 1977).

A female with offspring does not breed, so that on the average she has only one litter every three years. Since most females breed first at age four* or five**, and cease bearing young beyond the age of about 24 (Stirling et al. 1978), approximately five litters could be reared within a full reproductive life span. In the Western Arctic, however, the average age of females with cubs was only 10 years and the average litter size was around 1.66, indicating that most females in that area may have only two litters and rear just three cubs (Stirling 1977).

The productivity of other populations appears to be similar, which means that in general this species has a very low reproductive potential. Some parameters such as the age of first breeding and average litter size may vary according to changes in the environment, habitats, or population size. The role of possible compensatory mechanisms in reproduction is unknown, and thus the response of a population to increased harvesting or environmental disasters cannot be predicted.

* Central and High Arctic (Stirling and Latour 1978).

** Western Arctic (Stirling et al. 1975).

Mortality

Polar bears have few enemies apart from man. Of all the mortality factors affecting this species, hunting is by far the most important. In a recent High Arctic study, hunting accounted for 44% of the population's annual mortality (Schweinsburg et al. 1980), and it is possible that this level is regularly exceeded in some areas each year. Approximately 700 bears are shot annually in Canada and, unlike natural predator-prey relationships, hunting pressures remain relatively constant despite local population fluctuations.

Starvation is a common cause of polar bear mortality, occasioned by changes in seal numbers or accessibility, but also by inexperience and physical disabilities. Weak and emaciated bears have been encountered at times throughout the Arctic, and dead bears found on occasion have either been diagnosed (Schweinsburg and Lee 1981) or presumed to have starved.

Although many females leave the maternity den with only one cub, placental scarring indicated that often another cub is born but does not survive (Larsen 1978). A number of studies have documented mortalities from the time of den emergence to the age of two-and-a-half years (Schweinsburg et al. 1980, 1981). Many deaths probably result from mishaps on the ice (Larsen 1978) and from predation by adult male bears (Russel 1975). Following the dispersion of family groups, a number of young bears die in their first years of independence, although mortality rates for this period are not extreme (Stirling et al. 1978, Schweinsburg et al. 1981, Stirling 1978b).

Adult male bears sometimes die in mating fights, and occasionally a bear may be killed by a walrus. Many bears probably drown in accidents on the sea ice, or during arduous open water crossings. Denning bears, and sometimes others, are occasionally killed by avalanches or snowslides (Larsen 1978).

The importance of diseases, such as trichinosis, to polar bear populations is unknown but might constitute a significant aspect of mortality. Cub predation by other bears and deaths due to mating fights between adult males are both factors which might function as density dependent population regulators, or "compensating mechanisms." The degree to which hunting by humans might replace natural deaths is unknown, and until it is known maximum sustained yields cannot be determined.

Population Dynamics

There are no reliable records of polar bear numbers in Canada prior to the present estimates, but historical accounts suggest that populations were reduced locally wherever sealing and whaling industries were located. These were principally along the coasts of Newfoundland, southern Labrador (Smith et al. 1975), Baffin Island and the mainland bordering the Beaufort Sea (Stirling et al. 1975). Whaling was also prevalent on the west side of Hudson Bay (Thomas 1978) and perhaps reduced that region's bear population to an extent still evident in the absence of maternity denning areas along the coast south of Chesterfield Inlet. Other factors, such as increased harvesting by indigenous peoples for the hide trade, may also have contributed to a general decrease in the world population.

The decline of Canada's polar bear population was formally recognized in 1935 when the Federal Government first took steps to conserve this species by instituting a closed hunting season (Slaney and Co. Ltd. 1974). Further protection was afforded by the Territorial government in 1949 when hunting rights were restricted to indigenous peoples (Manning 1971). The efficacy of those measures cannot be determined, but it is believed that the number of bears continued to dwindle, although maybe at a slower rate, until the mid 1960's when hunting from snowmobiles became popular. The sudden increase in the reported annual kills until 1967 (when quotas were introduced) (Fig. 3), may have reduced the population further, but no accurate means of assessing the impact existed at that time. Estimates of the Canadian population for that period are purely subjective and should not be compared with more recent figures based on better data.

Over the past 14 years, since the introduction of quotas and refined harvesting regulations, it is believed that most Canadian populations have been recovering or have stabilized. Bears have returned to some former ranges (Wager Bay, Churchill), and elsewhere populations appear to be sustaining current harvest levels, which in most cases equal or exceed historical averages. Since 1967, the only documented decline of a polar bear population occurred in the vicinity of the Beaufort Sea during the mid-1970's (Stirling 1978b).

The relative stability of polar bear populations is due to the longevity of adults and the low reproduc-

tive potential of the species. Because polar bears are highly mobile and will travel great distances in search of food, a comparatively rapid fluctuation in a particular population's density may be due as much, or more, to a migration than to productivity (Stirling 1978b).

The size and distribution of polar bear populations are primarily influenced, apart from hunting, by the abundance and accessibility of seals, which are ultimately dependent upon ice conditions and the productivity of the marine environment (Larsen 1978). Where seals are plentiful and easily caught, polar bears thrive; where either or both requisites are marginal, bears are scarce. Other extrinsic factors which could potentially limit populations, such as the availability of suitable maternity denning habitat and summer retreats, are considered to be of minor significance to most Canadian populations.

Intrinsic factors which contribute to the dynamics of polar bear populations are poorly understood, and investigations have been hampered by the lack of data with which to test hypotheses (Stirling 1978b). Compensatory mechanisms involving reproductive rates and sub-adult survival are believed to exist, but the degree to which they operate has not been determined. The role of density-dependent factors such as disease and social behaviour (e.g. cannibalism) is unknown.

Utilization

Before the arrival of Europeans, indigenous peoples hunted the polar bear for subsistence purposes. Now, however, only a few hides are retained in some settlements for domestic use (Northwest Territories Wildlife Service files). In remote areas, such as outpost camps, the meat may be consumed regularly, while elsewhere only young bears are still considered acceptable fare. The polar bear's hide had long been a valuable article of commerce in the Old World by the time traders reached Canada in the 17th century. Fur companies, chiefly the Hudson's Bay Company, have also dealt in polar bear hides since that era, although the total volume of their trade had never been computed. However, an average of 12 hides per year were brought to York Factory between 1854 and 1900, and three hides were received annually at Churchill between 1854 and 1886 (Stirling et al. 1977b). In recent times, about 300-400 hides have been sold each year by Canadian auction houses. Hides which are not shipped south for auction are usually sold privately by the hunter or a local Co-op (Smith 1977, 1978).

The price of polar bear hides has fluctuated over the past decade, with an early peak occurring in 1973-74 and a subsequent decline lasting until 1976-77. Since then average prices have risen annually

D. R. Urquhart

When properly dried and prepared, hides bring good prices at fur sales.

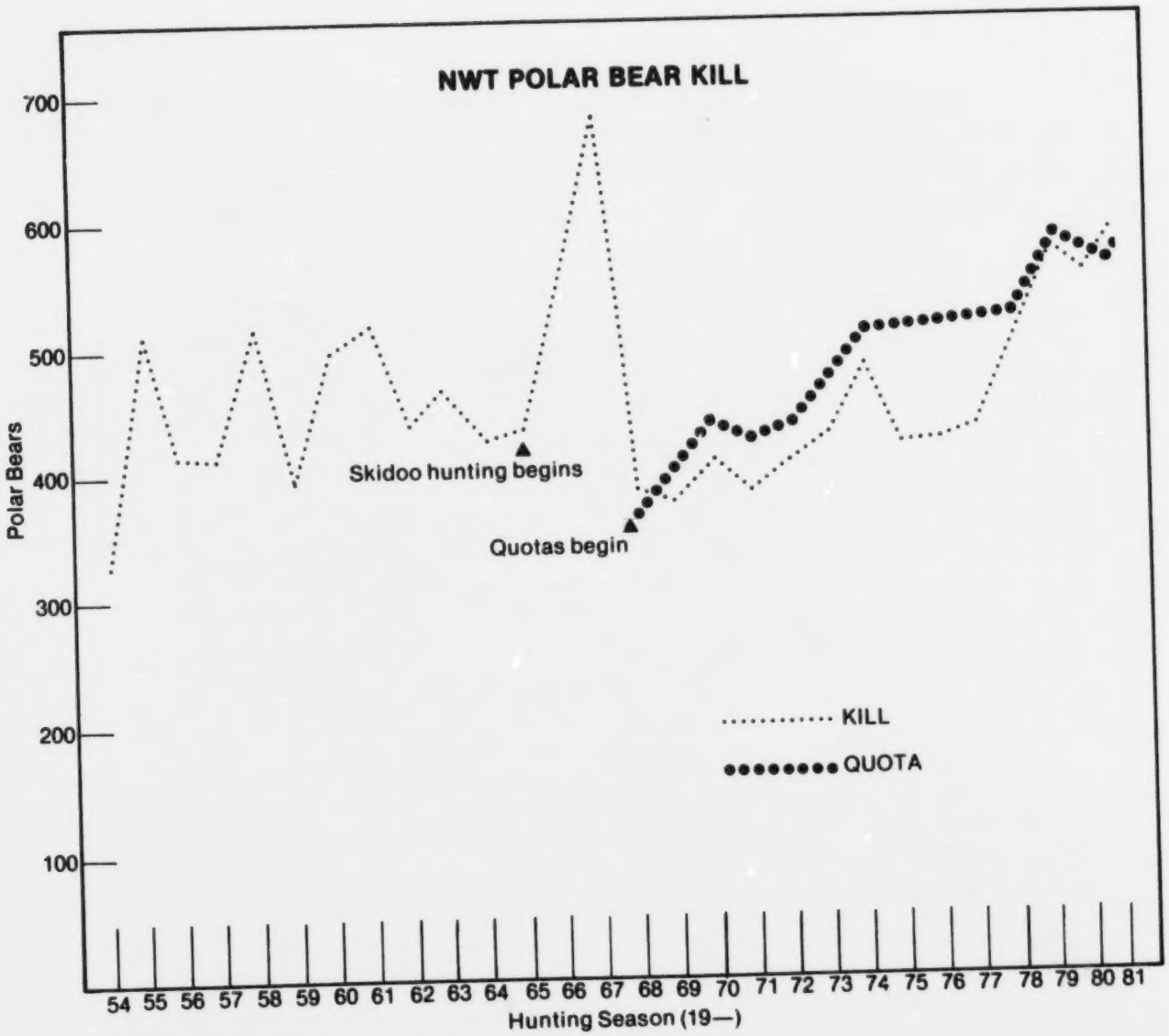


Figure 3. Polar bears killed in the N.W.T. 1954-81.

(Smith 1979, P. Smith pers. comm.). From a total of 350 known transactions in 1978-79, the average price paid to hunters was $1055 (P. Smith pers. comm.). The price of an individual hide depends on its size, quality, the care with which the skin was removed and prepared, plus the method of packing and shipping (Smith 1979). Hide treatment varies among hunters and settlements, some of which receive consistently low prices because of improper handling (Northwest Territories Wildlife Service files).

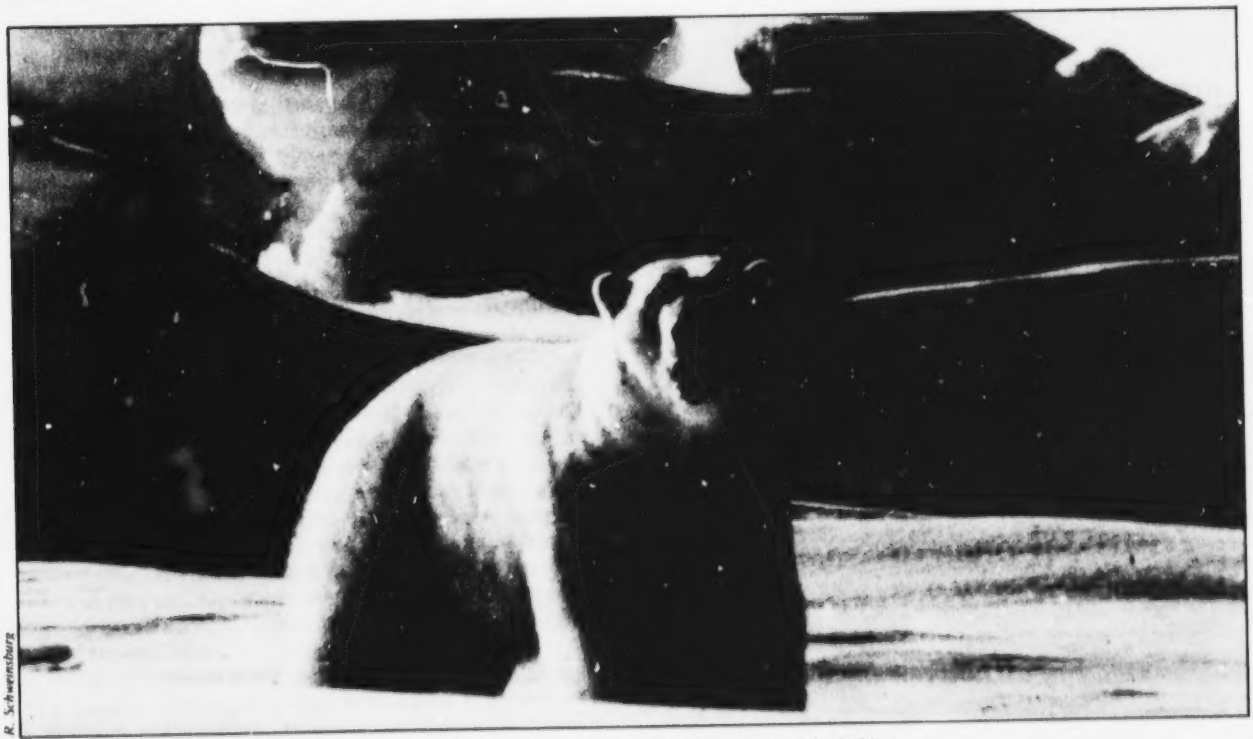
Table 2. Summary of commercial revenues from polar bears in Canada, 1975-76 to 1977-78 (Smith 1977, 1978, 1979).

Source	1975-76	1976-77	1977-78
No. of skins sold by auction	314	282	405
Price range of skins sold by auction	$85-1596	$10-1500	$35-1750
Average price paid for auctioned hides	$668	$612	$907
Total revenue from fur auctions	$209,752	$172,584	$367,335
No. of sport hunters	9	11	11
No. of bears killed by sport hunters	6	7	5
Average cost of a sport hunt (outfitting fee only)	$3750 ($3500-4000)	$4000	$4000
Total cash expenditure by sport hunters	$32,250	$35,439	$65,200
Total gross revenue from sport hunts and auctions	$242,002	$208,023	$432,535

Polar bear sport hunting began in 1970. Each year since then a few sport hunts have been offered by several of the nine arctic settlements involved in the program since its inception. The cost of a sport hunt varied between $3500 and $4500 from 1970 until the 1978-79 season when it rose to $10,000 (Northwest Territories Wildlife Service files), and then to $13,000 in the following year (Freeland pers. comm.). The fact that the sport hunting programs did not burgeon as anticipated has been attributed to many causes, including competitive hide prices (compared to guiding fees), lack of sled dogs, adverse weather, bad publicity from poorly organized hunts, the preference for maintaining the hunts exclusively as a cultural pursuit, and the attraction of wage employment during the sport hunting season. These factors will continue to fluctuate and recombine to affect future sport hunting. The proliferation of outpost camps may increase the number of sport hunts, but in general this use of polar bears will probably never assume much greater importance than it has in the past. This is because the tags used for sport hunting are part of the community quotas and are not reusable if the sport hunter is unsuccessful. Sport hunting actually decreases the total annual kill since, depending on the area, sport hunts are 50% to 75% successful.

Sightseeing tours are not offered in the Northwest Territories, although such excursions are undertaken from Churchill, Manitoba, in a specially constructed vehicle (C.B.C. Northern Television Service pers. comm.). The potential for boat tours to view bears in their summer retreats does exist in some regions of the Northwest Territories. A small amount of revenue is received in communities by the $10 apiece for a polar bear's lower mandible, and $25 for ear tags, lip tattoos, and reproductive organs, paid by the Canadian Wildlife Service (CWS) and the Northwest Territories Wildlife Service. Polar bear hides are often made by local artisans into rugs with stroud backing. Otherwise, craft manufacturing from the hides or teeth is rare in Canada (Jones pers. comm., Boose pers. comm., MacLeod pers. comm.). A thriving Japanese industry exists in the conversion of Canadian polar bear hides into fishing lures (Miller pers. comm.).

Each year a number of Inuit are employed by industrial companies as polar bear monitors. These men patrol in the vicinity of offshore and coastal drill rigs and at depots to protect the staff and property from "problem bears." Although they earn a wage for this duty, additional profits may be gained from the animals which they shoot. Bears are disposed of privately if they are taken on a settlement quota. If not, they are seized by the Northwest Territories Wildlife Service and the hide price obtained at a public auction is paid to the regional Hunters and Trappers Association (HTA). An incidental profit from polar bears is the occasional sale of cubs to zoos. Proceeds from such sales are consigned to the general government revenue.



R. Schwentzburg

Canada has signed an international agreement which obliges it to conserve the polar bear and its habitat.

Conservation and Management

Early legislation pertaining to wildlife management in the Northwest Territories* ignored the polar bear, and it was not until 1935 that the Federal Government limited hunting of this species to a season between 1 October and the following 31 May. In 1949, the first Game Ordinance** enacted by the Government of the Northwest Territories maintained the closed season and also restricted polar bear hunting to General Hunting Licence holders, most of whom were indigenous peoples.

Between 1953 and 1964 the annual kill of polar bears in the Northwest Territories fluctuated between 325 and 550, but after that date it began to rise steadily toward the unprecedented level of 726 bears in 1967 (Northwest Territories Wildlife Service files). In that year, hunting regulations incorporated a quota system by which the annual harvest for each settlement was limited to a number based on its previous harvest record and a crude estimate of the polar bear population in its vicinity. The entire quota for the first season (1967-68) was 375 bears. By 1981, that figure had risen to 597 by increments granted either in response to political pressures, or research results, or both. Quota controls are maintained by issuing tags to the Area Wildlife Officer who, in turn, transfers them to the local Hunters and Trappers Association, where they are allotted to members of the community and/or retained for sport hunts.

* An Act for the preservation of game in the unorganized portions of the Northwest Territories of Canada (Unorganized Territories Game Preservation Act, 1894, c.31).

An Act for the preservation of game in the Northwest Territories. (Northwest Game Act, 1906, c.151).

An Act respecting game in the Northwest Territories of Canada. (Northwest Game Act, 1917, c.36).

** An Ordinance respecting the preservation of game in the Northwest Territories. (Game Ordinance, 1949, c.12).

Since no fur auction, tannery, or reputable taxidermist will accept an untagged hide, there is little poaching incentive. A defense-killed bear, which is subtracted from a settlement quota, is tagged in the normal manner and becomes the property of the hunter or HTA involved. Usually, such animals are not included in a quota and are seized, in which case the meat is donated to nearby settlements and the hides are sold by auction with the proceeds paid to Regional HTA's. Since the 1977-78 season, quota increases have been in the form of special red tags, which can only be used after the regular quota is filled. Such tags (and the increase they represent) may be revoked at any time if necessary. A population decline, for example, might be grounds for revocation. In addition to the tag system, hunting regulations include: a closed season to protect pregnant females and family groups; a size restriction (minimum length 1.5 metres) to protect cubs and yearlings; and the prohibited killing of any bear accompanied by young to further protect family groups. In some areas, an attempt has been made to distribute the kill by designating portions of a settlement's quota to specific hunting areas and/or to restricted hunting seasons.

Bears are marked with black hair dye, so biologists can identify individual bears from the air and map their range.

The evalution of selective harvesting is of paramount importance to effective management of the species. Statistical simulations of population dynamics, employing data from the Western Arctic, have shown that the protection of productive females reduces the overall mortality rate of the population (Stirling 1978b). On the other hand, a relatively large number of males could be removed from a population without affecting its size.

Admittedly these conclusions are based on simplistic theories and models; further refinements of harvest control must await better data, in particular those which concern the value and functions of compensatory mechanisms. Such information would also be invaluble to impact assessments of industrial and other environmental calamities.

A year prior to the introduction of harvest quotas, the Canadian Wildlife Service (CWS) embarked on a series of population ecology studies which have been progressively defining the size and extent of Canada's polar bear populations (Stirling et al. 1977b). In collaboration with other research agencies, the CWS partitioned the entire Canadian range of this species into eight Polar Bear Management Zones. The original boundaries of those zones were designed to enclose what were presumed to be discrete populations (Smith et al. 1975). The zones, which functioned for many years solely as a reference for research and discussions, eventually received legal recognition in 1976 (Monaghan pers. comm.).

In 1972, the Northwest Territories Wildlife Service joined the CWS in polar bear research, primarily to guide harvest management in the Northwest Territories (Stirling et al. 1975, Schweinsburg et al. 1981). A third phase of research, which is receiving more attention, concerns the impact of industry on polar bears and vice-versa: specifically the effect of pollution on this species and the development of dependable polar bear deterrents. The results of such research will eventually be translated into regulations designed for the mutual protection of bears and humans.

Polar bear management has evolved over the past decade in response to the increased sophistication of research techniques, management methods, and public involvement. Each of those aspects is the concern of particular organizations whose combined efforts form the current management process. The individual organizations and their functions are:

(a) **The Polar Bear Technical Committee** (PBTC). This group is comprised of wildlife biologists from each of the provinces with polar bears, the two territories, and the Canadian Wildlife Service. They recommend management approaches based on analyses of research data, and may design specific regulations or review proposed regulations presented by any member.

(b) **The Polar Bear Administrative Committee** (PBAC). This group is comprised of the directors of each provincial or territorial wildlife service managing Canadian polar bears, plus the Canadian Wildlife Service. The committee responds to recommendations from the PBTC and drafts regulation changes. However, approval at this level is not mandatory, and occasionally regulations are enacted unilaterally by individual jurisdictions regardless of the majority consensus in the committee.

(c) **Hunters and Trappers Association** (HTA). These organizations are comprised of General Hunting Licence holders in most settlements of the Northwest Territories. Regulation changes are often developed through consultations between the Northwest Territories Wildlife Service and the involved HTA's, or else proposed changes are submitted to the appropriate HTA's for review. Regulation changes are rarely enacted without prior notification of the HTA's affected by them.

N. W. T. Renewable Resources

Valuable information about polar bear distribution can be gained through the return of ear tags.

(d) **Polar Bear Specialists Group of the Survival Service Commission** (PBSG). This group is coordinated by the International Union for the Conservation of Nature (IUCN) to encourage the responsible management of wildlife throughout the world. It provides a forum for international cooperation in polar bear research and conservation, which, in 1976, led to the declaration of an "Agreement on the Conservation of Polar Bears". As a signatory to the agreement, Canada is obliged to conserve the polar bear and its habitat, and to conduct research which will improve the management of this species.

Although the mandate to manage polar bears in the Northwest Territories has been delegated by the Federal Government to the Government of the Northwest Territories, federal intervention is permitted under certain conditions (e.g. gross mismanagement) by the Canada Wildlife Act and primarily the British North America Act.

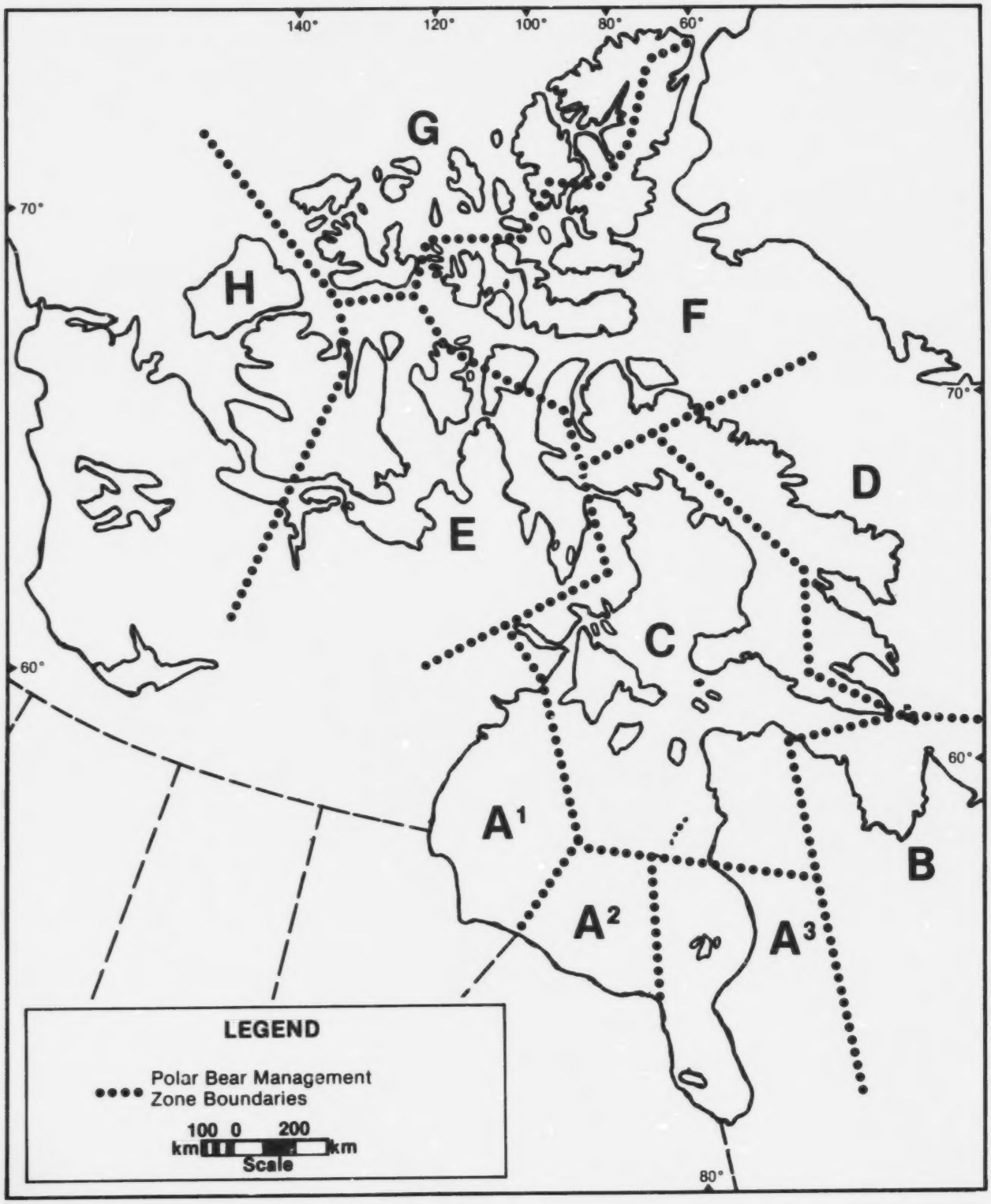


Figure 4. Polar bear management zones in Canada.

DISTRIBUTION

The distribution of polar bears in the Northwest Territories has been divided into eight zones (Figure 4). Each zone theoretically represents a population of bears belonging to an inter-breeding unit that is usually confined by land barriers, open water, or food resources and is thus separated from other similar groups of bears.

Within a zone, sub-populations may be defined in which a group of inter-breeding bears has a limited exchange (10% or less) with groups of bears within the same population. They have little or no contact with bears outside the population.

R. Schweinsburg

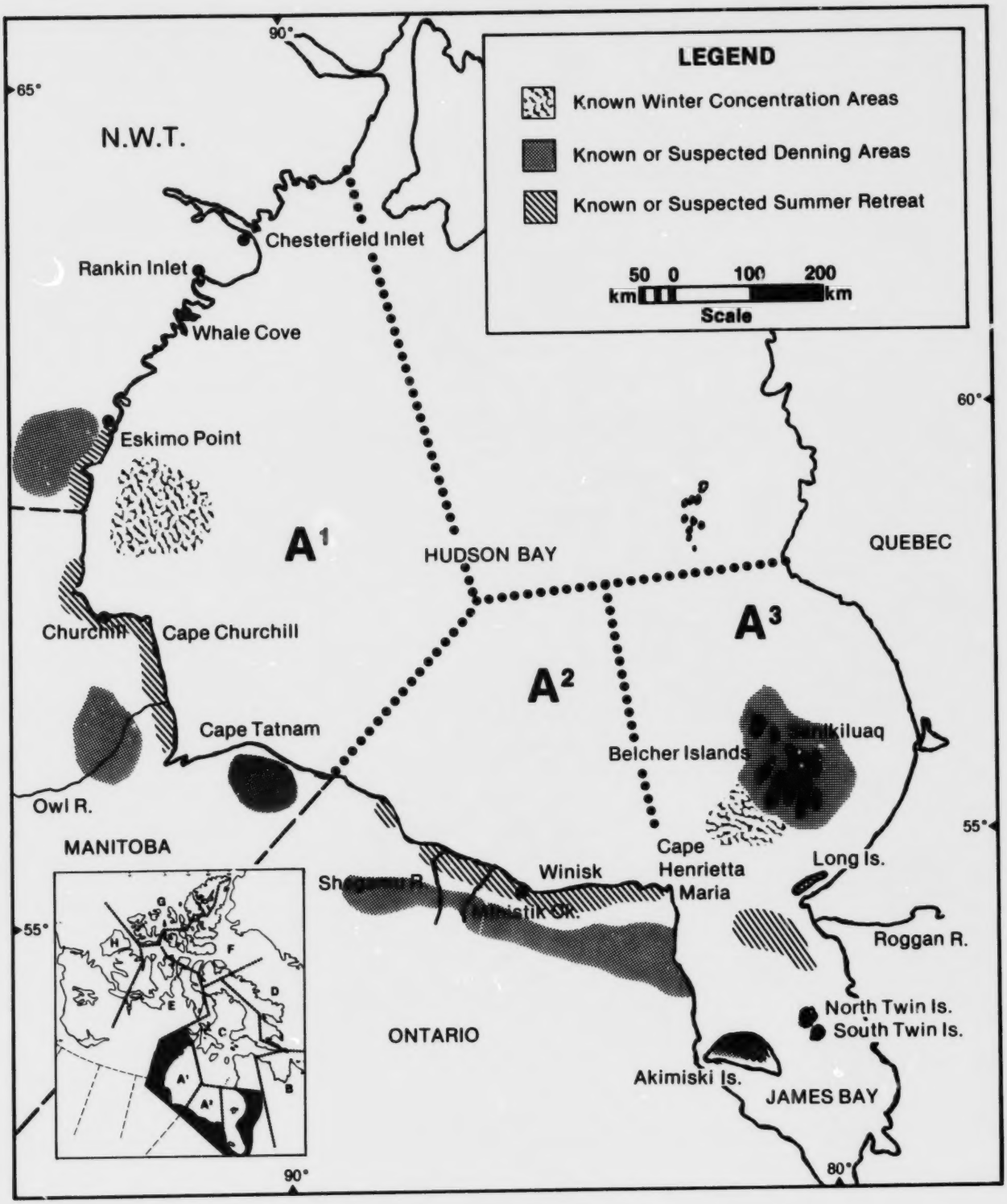


Figure 5. Zone A – James Bay and the southern half of Hudson Bay.

ZONE A

James Bay and the southern half of Hudson Bay are combined in this zone which follows one continuous coastline and is shared by four political jurisdictions (Fig. 5). Zone A supports the world's most southerly polar bear population and is the only place in Canada where this species is regularly hunted by Indians (Cree) as well as by Inuit (Stirling et al. 1977b). In the past, polar bear research has been focused on this area, and Churchill, Manitoba, continues to be an important centre for both laboratory and field studies of the species.

Hudson and James Bays together form an inland sea, surrounded by low wetlands and dunes, that is isolated from the warming influences of other oceans. Consequently, currents in those waters are weak and cold, prevailing winds are strong and cold, ice cover persists for much of the year, and ice conditions (break-up, drifting) are highly variable (Stirling et al. 1977b).

Population Status

Background

Population data for this zone were secured mainly from mark-recapture programs in: (a) Manitoba, where 227 bears were tagged between 1966 and 1975 (Stirling et al. 1977b); (b) the northern Ontario coast, where 29 bears were tagged between 1968 and 1973 (Jonkel et al. 1976); (c) the James Bay-Belcher Islands area, where 50 bears were tagged between 1968 and 1973 (Jonkel et al. 1976). Those projects were supported by concurrent aerial and ground maternity denning surveys, track counts, surveys of seal distributions, scat analyses (Russel 1975), age determinations, and compilations of harvest data. Other sources are: Northwest Territories Wildlife Service harvest data, minutes of PBTC meetings, and summaries of fur auction sales (Smith 1977, 1978, 1979; P. Smith pers. comm.).

Population range

The Zone A polar bear population has been divided into three sub-populations (A^1, A^2, A^3); however, the basis for these distinctions is tenuous (Stirling et al. 1977b). Since 1978 the boundaries of the sub-populations have not been altered but it is expected that future studies will result in some changes. In particular, it is possible that the Zone A^1-A^2 boundary is artificial and that bears from those two areas constitute one large interbreeding sub-population which has interchanges with bears from Zone C to the north and Zone A^3 to the east. The northern limit of the Zone A^1 sub-population has yet to be accurately defined (Gates 1980).

Seasonal distribution

Bears from Zone A^1 (and probably some from A^2) move on to the newly formed ice of Hudson Bay in November. This phase is preceded by a gradual fall movement northward along the coast to the region north of Cape Churchill and is likely related to the beginning of freeze-up in Hudson Bay which occurs first in that area. Bears which arrive prior to freeze-up may remain near the coast for 30 to 40 days awaiting suitable ice formation. A progressive accumulation of bears occurs annually there, with notable congregations on the Fox Islands off Watson Point and the small islands near Cape Churchill (Stirling et al. 1977b).

Although bears remain on the ice throughout the winter, little is known of their distribution or movements during that season. Tag-recoveries have shown that some bears from Manitoba move northward along the Keewatin coast and may reach the northern and northeastern portions of Hudson Bay (Zone C). It has been suggested that concentrations of bears may develop in association with a lead which often exists approximately 80 km offshore from Southampton Island to Churchill (Stirling et al. 1977b). A track survey in March, 1972, indicated a concentration of bears east and northeast of Churchill declining in density toward Southampton Island and central Hudson Bay (Stirling et al. 1977b). Annual variations in this pattern are unknown.

Bears probably stay on the ice as long as they can and finally come ashore on the Ontario and southern Manitoba coasts where remnants of the last ice floes are most persistent. On shore, bears tend to congregate on the capes and headlands of the coast,

possibly where summer breezes have the most cooling effect (Stirling et al. 1977b). A significant degree of spatial segregation appears to exist between most adult male bears which frequent the coast (within 1 km of the shore) and most family groups which are generally more common inland near the denning areas.

The annual cycle of movements is completed as bears begin to travel slowly northward again towards Cape Churchill. Apart from the presumed preference for open lead areas in winter and the aforementioned summer distributions, habitat selection and essential requirements for Zone A^1-A^2 bears are unknown. A large fall concentration occurs annually in the vicinity of Churchill, Manitoba, where bears have been congregating since the mid-1960's to feed at the town dump prior to freeze-up. These animals exhibit a remarkable fidelity to this area and attempts to remove them to sites a few hundred kilometres down the coast have met with little success (Stirling et al. 1977b). While they are near the town the bears pose a danger to the residents.* Precautions, such as moving the dump farther from town and/or completely incinerating the garbage, are as yet deemed too costly.

The bears of Zone A^3 spend their summers on most of the small islands in central and northern James Bay, northern Akimiski Island, several small islands west of Cape Henrietta Maria, Long Island (Jonkel et al. 1976), the outlying Belcher Islands and both North and South Twin Islands. Some bears may summer on islands adjacent to the Quebec coast, and along the Ontario coast where adult males congregate on the headlands and small islands.

Ice begins to form in James Bay in late October to early November and bears vacate the retreats as soon as ice conditions are suitable. During winter, pregnant females occupy maternity dens and other bears hunt along leads and near the edges of land-fast ice where seals are most accessible (Jonkel et al. 1976). Therefore, variations in the annual pattern of lead and land-fast ice formations strongly influence the distribution of bears throughout the winter.

A possible concentration of bears may form near the polynya at the confluence of James and Hudson Bays but this has yet to be verified (Jonkel et al. 1976). Mark-recapture data from this area indicate that most bear movements are confined to the James Bay/Belcher Islands region with a presumed northern limit for this population being somewhere northwest of the Belcher Islands.

The annual onset and pattern of break-up in James Bay vary greatly and likely govern the eventual choice of summer retreats by polar bears which remain on the ice until they are forced ashore some time between July and November.

Maternity denning

There appear to be no significant maternity denning areas along the entire Keewatin coast from Chesterfield Inlet to the Manitoba border and beyond to a point approximately 80 km south of Churchill. In Manitoba, the major maternity denning area is in the vicinity of Owl River with a smaller one located on Cape Tatnam. In Ontario, maternity dens are widely scattered, with a slight concentration between Shagamu River and Ministik Creek, west of Winisk (Stirling et al. 1977b).

In James Bay, maternity denning areas have been documented south of Cape Henrietta Maria and on Akimiski and Twin Islands (Stirling et al. 1977b). Another possible maternity denning area in Zone A^3 is inland, north of Roggan River, Quebec.

* Some employees have "bear clauses" in their contracts permitting them to stay home on "bear days", or making the employer responsible for their safe transportation to and from work.

G. Stenhouse

At the site of deterrent research, Cape Churchill, Manitoba, an electrified fence failed to halt the progress of this bear.

Numbers

An accurate population estimate for the entire zone from existing data is not possible. A rough estimate for the Churchill area in 1975 was 1075 bears based on the Lincoln Index method (Stirling et al. 1977b). The same technique was also used to calculate a 1973 total of 374 bears for James Bay (Jonkel et al. 1976). Both figures are regarded as very crude approximations and are employed with caution in any management decisions.

Productivity and mortality

The average litter size produced in Manitoba between 1970 and 1976 was 2.0 cubs, which is considerably higher than that of more northerly populations. From those data it has been suggested that about 80 females and 150 cubs emerge from maternity dens in Manitoba each spring. Estimates of productivity for the James Bay area are not possible from existing data, nor are mortality rates for either area (Schweinsburg 1980).

Utilization

Polar bears in Zone A are hunted by native residents of the Northwest Territories, Manitoba, Ontario and Quebec. In the Northwest Territories, five communities harvest bears on a quota basis which has been in effect since 1967 (although until 1974 the quotas were taken from Zone C whose southern boundary until then was the Manitoba-Northwest Territories border) (Gates 1980). In the three years 1976-79, an average of 66* bears were taken annually from Zone A by Northwest Territories Inuit (Tables 3 and 4). Manitoba and Ontario have allowable kills of 35** and 30*** respectively but those are not administered in the form of settlement quotas. Quebec Inuit were once believed to be harvesting about 72 bears a year from Zones A, C and B-D, but recently the annual total has been below that (Stirling pers. comm.). A settlement quota system is being devised by the province for those people.

* including defense kills
** usually fewer than 15 bears are shot annually
*** 25 in A^2 and 5 in A^3

Table 3. Summary of polar bear utilization in Zone A by N.W.T. residents, 1976-77 to 1978-79 (Smith 1977, 1978, 1979; P. Smith pers. comm.).

Settlement	Quota				Known kill*			Average hide price paid to hunters in $ (no. of hides)		
	1976	1977	1978		1976	1977	1978	1976	1977	1978
			Reg. tag	Red tag						
Chesterfield Inlet	8	8	8	2	7	8	7	?	?	966(7)
Eskimo Point	15	15	15	4	15	15	20	475(12)	783(14)	778(16)
Rankin Inlet	9	10	10	3	10	10	12	?	?	?
Sanikiluaq	20	20	20	—	16	20	21	597(16)	889(2)	1280(20)
Whale Cove	12	12	12	1	12	12	13	?	979(7)	928(12)
Total	64	65	75		60	65	73	$15,252	$19,593	$55,946

? no data
* Includes defense-kills in excess of quota

Polar bears are generally harvested by Northwest Territories residents in this zone for the sale of the hide, usually by auction (Table 3). Hide sales are also permitted in Quebec and Ontario but not in Manitoba, where bears can be taken strictly for subsistence or as defense-kills. Sport hunts have never been offered in this zone.

In the past, general alterations in Northwest Territories hunting regulations have all applied to Zone A, with the important exception that the Keewatin communities rejected the 1979 season change to a 1 December opening. In consequence they did not receive the quota increment of 10 red tags previously allotted to them in 1978, since the increase was permitted partially on the assumption that family groups would be receiving greater protection from the delayed opening. Subsequent analyses of harvest data, however, suggested that in Zone A, unlike others, mature females do not comprise a large proportion of the fall kill (Table 4) and thus the assumption which prompted the removal of the red tag quota may not be as valid as originally perceived.*

Industrial Activity

The first exploratory well was drilled in Hudson Bay by Aquitaine Co. in 1969. The company returned in 1974 to cap that well and drill two others (Ebert pers. comm.). All operations, both seismic and well drilling, were conducted during the summer, the former by ship and the latter from semi-submersible rafts. Those activities comprise the total fossil fuel exploration in Hudson Bay (James Bay remains unexplored). A few exploration permits are currently held for central and northern Hudson Bay (none for James Bay) but the likelihood of an early resumption of activity there is slight (Ebert pers. comm.). Mineral exploration is limited to inland regions of the Keewatin and is restricted to the summer with some transportation of supplies overland and by air in the winter.

* The red tag quota was reinstated, Dec. 1980.

Table 4. Sex and age composition* of polar bears harvested between 1968 and 1979-80 by Eskimo Point, Rankin Inlet, and Whale Cove (Gates 1980).

	Male Age Class					Female Age Class				
	0-4	5-9	10-14	15-19	20+	0-4	5-9	10-14	15-19	20+
Number	66	32	7	6	3	39	15	4	4	1
Percent	37.3	18.1	4.0	3.4	1.7	22.0	8.5	2.3	2.3	0.6
Average age			5.8					4.9		
	(SD** 5.03)		(N*** = 92)			(SD 4.61)		(N = 51)		

* Only samples of known sex and age included
** SD = One Standard Deviation
*** N = sample size

Problems

The Zone A population spans four jurisdictions: the Northwest Territories, Manitoba, Ontario, and Quebec. Conflicts have arisen over the belief that Keewatin hunters are taking bears produced in Manitoba. The dispute could become aggravated if hide sales or sport hunting is permitted in that province.

Also, the allotment of 15 bears from Manitoba to the Northwest Territories' annual quota could be cancelled anytime at the request of that province. Another inter-jurisdictional problem concerns polar bear hunting by Ontario and Quebec natives on offshore islands which belong to the Northwest Territories. The legality of that situation has never been settled.

Population data for Zone A are inadequate for management purposes. Specifically, there is no accurate estimate of the total population or the sizes of sub-populations in the zone. Seasonal movements are not well documented and thus boundaries between sub-populations and between Zones A and C are indefinite. Lack of accurate information in that area continues to hamper quota allocations and will confound future territorial-provincial negotiations concerning hunting rights. Although mature females may not be particularly threatened by fall hunting in Zone A', hide quality at that time is definitely inferior and the value realized for fall kills is substantially less than if the same animals were taken at a later date. Also, regardless of season, poorly prepared hides never bring optimum prices and this area is reputed to produce a number of them each year (Northwest Territories Wildlife Service files).

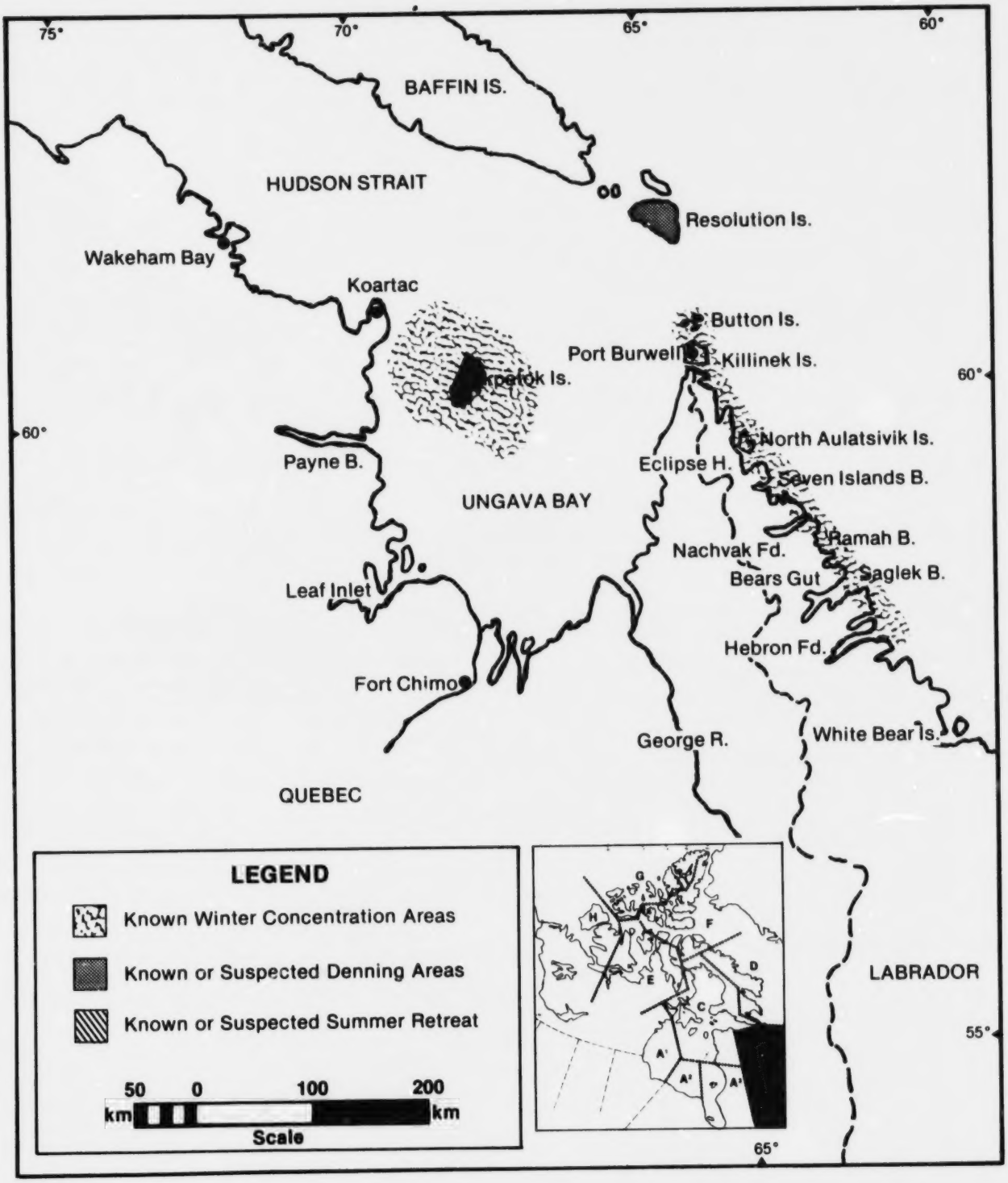


Figure 6. Zone B – Ungava Bay and the Labrador Coast.

ZONE B

Ungava Bay and the Labrador coast are combined in this zone which covers the southeastern extremity of the polar bear's range in Canada (Fig. 6). Since the abandonment of Port Burwell in 1978, this has become the only zone in which polar bears are not hunted by Northwest Territories residents. However, the region still merits attention by the Northwest Territories since it contains important polar bear habitats (offshore islands) which are under territorial jurisdiction, and also because of the possibility that the present Zone B boundaries do not enclose a discrete population but only part of a larger one shared by neighbouring Zones C and D (Stirling et al. 1980).

The coast of Labrador is mountainous and notched by numerous narrow fiords, while the Ungava region is much less rugged with its coast scalloped by broad bays. Ocean currents in both areas circulate counter-clockwise with a stronger southward component which carries ice floes through Hudson Strait and along the Labrador coast (Stirling and Kiliaan 1980). In the latter area, land-fast ice is largely confined to coastal indentations and a more or less permanent lead exists between land-fast ice and the pack ice, due to prevailing winds. The proximity of large bodies of open water in Davis Strait during winter ameliorates the climate of Labrador (Stirling and Kiliaan 1980).

Population Status

Background

Population data for this zone are far from complete owing to the high cost of logistics and the low density of bears. An attempt to tag bears on Akpatok Island in 1971 was unsuccessful and only 10 bears were tagged there in 1974 (Smith et al. 1975). The following description of bears in this zone is based almost exclusively on the results of a brief mark-capture study conducted on the Labrador coast between 1976 and 1979 in which 37 bears were tagged (Stirling and Kiliaan 1980). Harvest data for the period 1971-75 and historical observations dating from 1497 have also been summarized for the entire zone (Smith et al. 1975).

Population range and Seasonal distribution

A winter concentration area reportedly occurs around Akpatok Island, but it has not been well documented. On the Labrador coast during the months of March and April, bears tend to concentrate along the floe edge, especially around the mouths of bays (Stirling and Kiliaan 1980). Tracks and animals were most frequently encountered between Hebron Fiord and Seven Islands Bay. Bears on the pack ice most likely come ashore between Nachvak Fiord and Okak Bay since the pack is closest to land in that region. Bears have been observed on ice floes far from shore in the Labrador Sea, but it is not known what proportion of the Zone B population they represent. It is believed that the number of bears in this area must fluctuate greatly from year to year, in synchrony with varying ice conditions, such as floe size and the extent of ice coverage.

Some bears tagged in the spring along the northern Labrador coast were recaptured near the same location one or more years later. However, others tagged travelled extensively, reaching southeastern Baffin Island and Southampton Island within a few months (Stirling and Kiliaan 1980). Those results have led to speculation that considerable mixing occurs among these areas. Ocean currents which flow southward from Baffin Island and Hudson Strait could bring bears from the north on ice floes and deposit them in spring along the Labrador coast (Stirling and Kiliaan 1980). Those animals may then make their way northward again to their point of origin. The number of bears which circulate in this manner, and the exact pattern of their movements, remains unknown.

The implication is that, since such mixing appears to be an annual occurrence, Zone B does not support a discrete population but part of a larger one including bears from Zones C and D. Yet the results from an extensive mark-recapture program on southeastern Baffin Island (Stirling et al. 1980) suggest that little of that island's population participates in long-distance migrations. Perhaps because the Zone B population is considerably smaller than that of southeastern Baffin Island, the significance of the movements is of greater importance to the former area than to the latter in terms of the percentage of animals involved. The summer distribution of polar

bears in Zone B is largely unknown, but from the small number of sightings has been inferred to consist of a concentration of animals on Akpatok Island with very few animals spending the summer elsewhere in the zone (i.e. in Labrador proper). This situation has been tentatively ascribed to the likelihood that many bears summer outside Zone B entirely (Stirling and Kiliaan 1980).

The apparent instability of this zone's polar bear population may be a manifestation of the cyclic pattern of ice movements in the Arctic (Stirling and Kiliaan 1980). Thus Zone B may be a theatre for the periodic advance and retreat of the southern range limit for this species. At present, this polar bear range could be in a retracted phase, with most bears only temporarily occupying the zone. However, in succeeding decades, as ice conditions enter another stage, the range might extend farther south as it did in the past with a simultaneous increase of resident bears in areas such as the Labrador coast, now occupied by only a few animals on a permanent basis (Stirling and Kiliaan 1980). A simpler explanation is that polar bears were over-harvested in the past and numbers have been depressed since then by continuous hunting pressures (Luttich pers. comm.).

Maternity denning

Traditonal accounts of polar bear denning cite Button, White Bear, the North Aulatsivik Islands and the coast between Saglek and Seven Island Bays. They do not indicate the relative importance of those areas, nor the specific type of denning activity involved (Smith et al. 1975). Aerial surveys between 1970 and 1975, together with Inuit reports obtained during that period, identified possible maternity denning at Seven Islands Bay, Eclipse Harbour, and in the Ramah Bay-Bears Gut area (Smith et al. 1975). Akpatok Island and Resolution Island may also be maternity denning areas. Despite the apparent availability of suitable denning habitats in northern Labrador, very little maternity denning seems to occur along the coast or anywhere else in Zone B, possibly because of the effects of climatic changes or particularly hunting pressure.

Numbers

Since many bears may not reside permanently in this zone, the population size could be fluctuating seasonally with a general increase during winter and a progressive decrease toward late summer and fall. A total population estimate for the entire zone in any season is unavailable. However, an estimate for the northern Labrador coast in spring was 60-90 animals based on data from 1976 to 1979 (Stirling and Kiliaan 1980). At that time of year, bears are also presumed to be present at a similar density (very low) in Ungava Bay (Stirling pers. comm.), particularly in the vicinity of Akpatok Island. Thus the total number of animals in Zone B in spring is believed to be quite low, and presumably would become even smaller as bears vacated the area later in the year.

Productivity and mortality

Out of only 12 female bears captured between 1974 and 1979, six were accompanied by cubs (Smith et al. 1975). Consequently a detailed analysis of productivity is not possible, but a gross comparison with other zones suggests that productivity is low in Zone B (Stirling and Kiliaan 1980). Sample sizes are also too small to calculate mortality rates.

Utilization

Historically, polar bears were hunted by Inuit, whalers, sealers, settlers, and local residents of Ungava Bay and Labrador. In the past few decades, about 20 bears have been killed along the Labrador coast, mainly between Saglek Bay and Cape Harrison. Akpatok Island has long been a major hunting area for local Inuit. Between 1971 and 1975, a total of 142 bears were killed in Zone B (Table 5), most of the harvest coming from the Labrador coast, Killinek and Akpatok Islands, and western Ungava Bay north of Payne Bay (Smith et al. 1975). From 1967 to 1978, a quota of eight bears was allotted to the Inuit of Port Burwell by the Northwest Territories government.

Table 5. Known numbers of polar bears killed in Zone B, 1971-72 to 1974-75.

Location	Known Kill			
	1971-72	1972-73	1973-74	1974-75
Port Burwell	4	10	8	5
George River	2	7	4	6
Fort Chimo		1	5	5
Leaf Inlet		0	1	0
Payne Bay		7	9	24
Koartac	2	1	4	1
Wakeham Bay	5	14	6	0
Newfoundland		6	0	0
Norwegian sealers	2	2	0	1
Total	15	48	37	42

Harvesting by Quebec Inuit was not regulated until a 1975 provincial Order-in-Council established a closed season from 1 June to 30 September and provided protection for denning bears, females with cubs and cubs under one year (Polar Bear Technical Committee 1970-1979). As yet, there is no limitation of the total harvest* in Quebec although the provincial government is currently in the process of determining quotas for each settlement (based on past harvests). Upon the abandonment of Port Burwell in 1978, the quota of eight bears for that settlement was equally divided between Quebec, where it will likely become incorporated into the George River quota, and Newfoundland, where it would become the quota for that province (Stirling pers. comm.), if and when a season is reopened there.

Harvests between 1971 and 1975 appear to be excessive in relation to the probable population of Zone B but might not constitute an over-kill if, in fact, this zone is part of a larger population (Stirling and Kiliaan 1980). With the exception of Koartac residents, who subsist to some extent on bears during the winter (Smith et al. 1975), animals are taken primarily for the commercial value of the hides. Sport hunting has never been offered in this zone.

* A quota of 42 bears has been recommended by the Polar Bear Technical Committee since 1974 but has never been implemented.

Industrial Activity

Seismic exploration in the Labrador Sea commenced in 1969 and each year since then this area has been searched for hydrocarbon deposits. Between 1971 and 1979 a total of 17 offshore wells was drilled, five of which showed gas deposits. Although some of the reserves appear to be quite large, none are of proven commercial value to date. Activity in the 1980 season focused on follow-up drilling to determine the extent of some deposits with negative results as of November 1980 (Yungblut pers. comm.). Oil has not been found in the Labrador Sea. Undoubtedly, petrochemical exploration will continue in this area for some time at unpredictable levels, contingent upon the vicissitudes of the oil market, international politics, and future discoveries.

Problems

The status of Zone B polar bears is poorly known, both in terms of population ecology and utilization. Efforts to study bears in the area are frustrated by the high cost of logistics and the difficulty of obtaining representative samples. The possibility that bears in this zone are part of a larger population will continue to hamper management of this and adjoining zones until the relationships have been clarified. Quebec Inuit hunt bears on the offshore islands of the Northwest Territories and in Labrador essentially without monitoring or restraint. It is clear, however, that a large proportion of the harvest comes from Akpatok Island, Northwest Territories, which is also the major known summer retreat and possibly the most important maternity denning area in the Zone.

Offshore fossil fuel exploration and production activities may increase dramatically in the future, posing a threat to both polar bears and their habitats as well as multiplying man-bear conflicts.

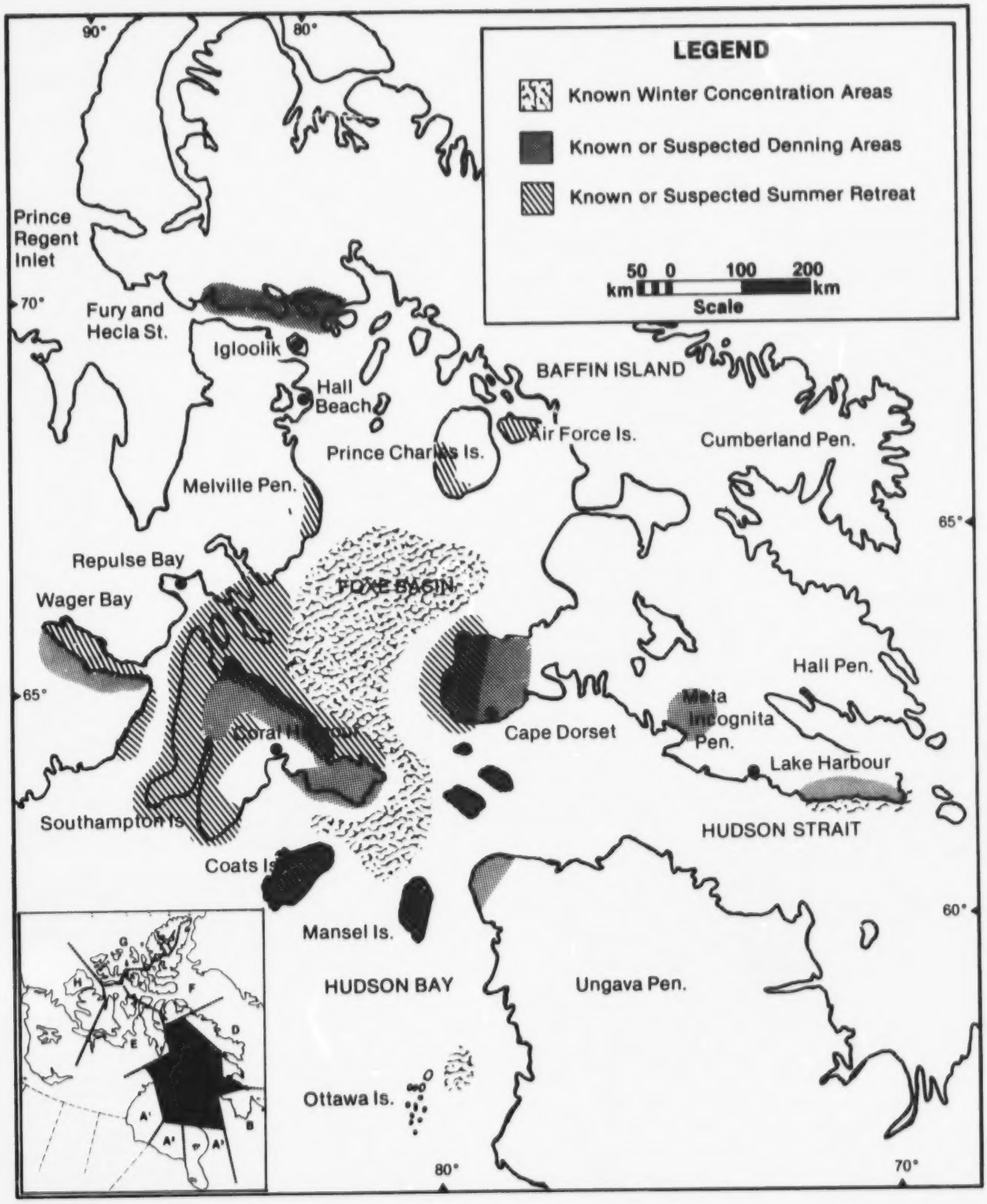


Figure 7. Zone C – Foxe Basin, northern Hudson Bay, and western Hudson Strait.

ZONE C

Foxe Basin, northern Hudson Bay, and western Hudson Strait are combined in this zone which is reputed to support a large number of polar bears and, in fact, has the largest combined quota of all the zones (Fig. 7). There is no population estimate for this zone, and since it is surrounded by others for which there is considerably more information on population status, it represents a central blank in the overall understanding of polar bear ecology in the Eastern Arctic.

The climate of this zone is typically arctic (short, cool, wet summers and long, cold, dry winters) as it is isolated from the warming influences of the North Atlantic Ocean and fed by the cold waters of the Central Arctic. The predominant current north of Southampton Island issues from Fury and Hecla Straits in the northwest, flows southward through Foxe Basin and exits via Hudson Strait. There it meets a weaker northbound current, creating a slow anti-clockwise circulation, with a stronger southern component that carries ice floes into Davis Strait and the Labrador Sea (Stirling et al. 1980). South of Southampton Island, currents are weak and complex but tend to circulate within Hudson and James Bays (Stirling et al. 1977b). Winter ice conditions vary from almost total coverage in the south (Hudson Bay) to large areas of open water with drifting ice floes in the north (Foxe Basin). Marine productivity in the zone is intermediate between the North Atlantic and the High Arctic.

Population Status

Background

In 1973, 16 bears were tagged in Foxe Basin but none were recovered (Manning 1973). About 30 bears were tagged at the extreme eastern periphery of the zone from 1976 to 1977, during a mark-recapture program on southeastern Baffin Island (Stirling and Kiliaan 1977). No other mark-recapture programs have been undertaken in this zone. The denning habits of polar bears on Southampton Island were studied between 1961 and 1964 (Harington 1968). A number of maternity denning surveys have covered various sections of the zone in the past (Ayotte 1977, Davidge 1980, Kraft 1978, Jonkel et al. 1978), and incidental observations from other projects have also contributed relevant data. A preliminary analysis of harvest data from Coral Harbour has been completed (Gates 1980), and the results of fur auction sales since 1975 have been summarized (Smith 1977, 1978, 1979; P. Smith pers. comm.).

Population range

The discreteness of the Zone C population has not been documented, but a vague impression of its status can be gleaned from the results of peripheral mark-recapture studies. Three bears radio-tagged at Churchill, Manitoba (Zone A[1]), subsequently crossed Hudson Bay to Southampton Island and Quebec (Stirling et al. 1977b). Other results have shown that many bears travel up the Keewatin coast in the fall, but whether they regularly reach Chesterfield Inlet or not is uncertain. The concentration of tagging effort in the vicinity of Churchill may have distorted the apparent range of Zone A[1] bears such that their affinity with Zone C along the western coast of Hudson Bay may be greater than the data suggest. None of the bears tagged in James Bay were recovered beyond the Zone A[1]-C boundary, but since few animals were tagged in the Belcher Islands, the apparent separation may be mostly a function of sampling effort (Jonkel et al. 1976). Thus the Zone A-C boundary must be considered only as an approximation, particularly since winter movements in Hudson Bay are unknown.

An apparent connection between bears of Zones B and C has been suggested from mark-recapture studies on the Labrador coast (Stirling and Kiliaan 1980), but the degree of exchange between those areas is not clear. It seems possible that each year some bears from Zone C drift through Hudson Strait on ice floes during the winter, come ashore on the Labrador coast in the spring, and return to their place of origin by the following winter (Stirling and Kiliaan 1980). One of the few bears tagged on the south side of Meta Incognita Peninsula (Zone C) was eventually recovered on the Hall Peninsula (Zone D) (Stirling et al. 1980). Possibly the division of Meta Incognita Peninsula into two separate populations is inaccurate. Local movements were recorded among bears tagged near Cape Dorset and Lake Harbour between 1974 and 1977 (Stirling and Kiliaan 1977), suggesting that some distinction may be made between bears of southern Baffin Island (Zone C) and those of southeastern Baffin Island (Zone D). In the latter area, movements of many animals marked on Hall and Cumberland Peninsulas also appear to be quite localized (Stirling et al. 1980).

Since the mark-recapture study in Zone E omitted sampling in the area adjacent to Zone C (Committee Bay, Fury and Hecla Strait) (Schweinsburg et al. 1980), the relationship between bears of those two zones is unknown. It is believed that the bears of Foxe Basin may constitute a discrete sub-population within Zone C. Also, in consideration of the general pattern of ice conditions in the zone, it may be that the bears south of Southampton Island represent another sub-population. So far these distinctions are purely hypothetical.

Seasonal distribution

A comprehensive description of seasonal distributions within this zone is not possible. However, a few observations and deductions concerning seasonal movements and concentrations can provide some idea of such activities in this area. It has been suggested that during winter bears in Hudson Bay may become concentrated in the vicinity of a lead which annually forms about 180 km offshore, extending from Southampton Island to Churchill (Stirling et al. 1977b). Since break-up in Hudson Bay usually begins just south of Southampton Island (Stirling et al. 1977b) it is assumed that the few bears in that immediate area (Zone C) withdraw toward Coats and Mansel Islands, while those further south (Zone A) remain on the ice until they are forced ashore along the southern coast of Hudson Bay. Thus Coats and Mansel Islands may be the major summer retreats for a small Zone C sub-population south of Southampton Island.

Bears north of Southampton Island frequent the land-fast ice during winter, along the southern half of Melville Peninsula. Few bears inhabit the north half of the peninsula where their density declines progressively towards Fury and Hecla Strait which is vacant. Many bears also seem to spend the winters adrift on large ice floes in Foxe Basin. In August and September strong northeasterly winds may drive these floes against the east coast of Southampton Island (Harington 1968). As many as 180 bears have been counted in that area, chiefly because of this phenomenon. Southampton Island is therefore a major summer retreat for the bears of Zone C, although the number of bears using that area varies considerably from year to year depending on ice conditions (Harington 1968). Prince Charles and Air Force Islands are also retreats in summer for bears of Foxe Basin which is largely ice-free during that season.

Maternity denning

The northeast coast of Southampton Island is the major known maternity denning area in Zone C (Harington 1968). Other important maternity denning areas in this zone are Mansel Island and the south side of Wager Bay (Ayotte 1977, Davidge 1980). Coats Island is also a known location for maternity denning although of considerably less importance than the others (Gates 1980). Denning surveys to date have not achieved complete coverage, and additional maternity denning areas may yet be discovered in this region.

Numbers

A total population estimate of this zone is not possible from existing data. If the harvestable surplus constitutes 5% of the population, then it would require about 3000 bears to sustain the 1981 quota of 143 animals.

Productivity and mortality

The overall mean litter size of parous female bears in Zone C was 1.87 cubs/female, calculated from observations made at various maternity denning areas between 1961 and 1978 (Harington 1968, Gates 1980) (Table 6). Other population parameters for this zone are not available from existing data.

Table 6. Mean litter sizes for parous female polar bears in the vicinity of maternity denning areas in Zone C.

Area	Cubs/ female	Mean litter size	Years	Source
Southampton Island	31/16	1.94	1961-64	(Harington 1968)
Southampton Island	34/19	1.79	1975	(Gates 1980)
Mansel Island	15/9	1.67	1978	(Gates 1980)
Wager Bay	53/27	1.96	1978	(Gates 1980)
Total mean litter size = 133/71 = 1.87 cubs/female				

Utilization

Since 1978-79, polar bears have been hunted by seven communities in Zone C with a combined quota of 143, which is the largest per zone in Canada. The average annual harvest for this area between 1976 and 1978 was 129 bears, of which almost 50% were taken by Coral Harbour (Table 7). The commercial value of the hide is the prime motivation for hunting, but although hide prices have risen in the past few years, the fur market is unstable and future increases are by no means certain. Polar bear sport hunting was offered by Coral Harbour from 1972 to 1974. Its early demise has been attributed to a preference for maintaining this activity as a cultural pursuit rather than selling the privilege to outsiders. Also, as hide prices escalated in the early 1970's, the margin between the commercial value of a hide and that of a guide's fee for a sport hunt became insufficient to warrant the extra effort required for the latter.

Table 7. Summary of polar bear utilization in Zone C, 1976-77 to 1978-79 (Smith 1977, 1978, 1979; P. Smith pers. comm.).

Settlement	Quota				Known kill*			Average hide price paid to hunters in $ (no. of hides)		
	1976	1977	1978		1976	1977	1978	1976	1977	1978
			Reg. tag	Red tag						
Cape Dorset	10	10	10	—	9	10	10	600(2)	1000(7)	981(10)
Coral Harbour	65	65	65	—	63	66	66	557(51)	553(61)	985(62)
Hall Beach	7	7	7	—	6	8	4	?	821(6)	?
Igloolik*	18	18	18	—	7	19	9	498(8)	600(4)	?
Lake Harbour	13	13	13	—	13	9	13	761(9)	964(5)	?
Rankin Inlet	10	10	10	—	9	10	2	?	?	1106(9)**
Repulse Bay	16	16	16	4	17	16	20	736(11)	496(13)	1716(4)
Total	139	139	143		124	138	124	$48,536	$59,327	$87,698

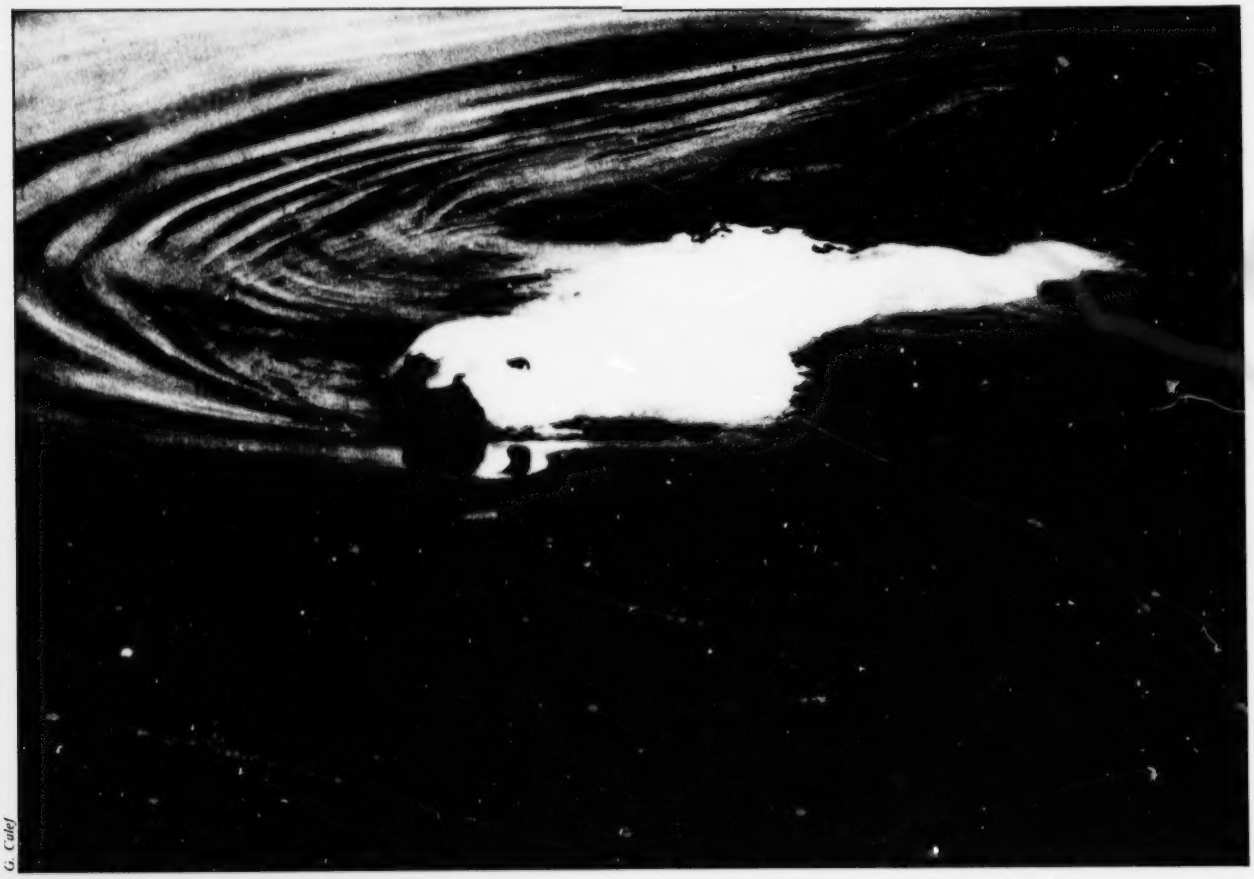
? no data
— no quota
* Kill may sometimes come from Zone E.
** Discrepancy between harvest and hide sale probably due to combination of 1977 and 1978 hides in 1978 auction.

The unusually large quota allotted to Coral Harbour was originally based on average harvests prior to 1967, which were high because Southampton Island, as both a major denning area and summer retreat, caused bears from Zone C to concentrate. Between 1968 and 1979-80, 78.5% of the total number of females taken on Southampton Island were killed in the fall prior to denning (Gates 1980). The hunting season for that community still extends from 1 October until the following 31 May, which does not protect denning family groups and pregnant females. Despite this situation, the harvest is apparently being sustained although the effect on the total population of the area is unknown. Only the composition of the Coral Harbour harvest has been analysed (Table 8), but without control data (e.g. from mark-recapture studies) it is not possible to relate harvest selection to the overall population. However, it seems likely that in view of the hunting patterns of Coral Harbour residents, a number of pregnant females are killed each year.

Table 8. Sex and age composition* of polar bears harvested between 1968 and 1979-80 by Coral Harbour (Gates 1980).

	Male Age Class					Female Age Class				
	0-4	5-9	10-14	15-19	20+	0-4	5-9	10-14	15-19	20+
Number	68	42	21	13	8	51	32	22	10	3
Percent	25.2	15.6	7.8	4.8	3.0	18.9	11.9	8.1	3.7	1.1
Average age			7.4					6.8		
	(SD** 5.75)		(N*** = 121)			(SD 4.87)		(N = 105)		

* Only samples of known sex and age included
** SD = One Standard Deviation
*** N = sample size



G. Calef

Polar bears are excellent swimmers. Occasionally they have been spotted swimming far offshore in open water.

Industrial Activity

Foxe Basin has not been subjected to fossil fuel exploration and Hudson Bay has so far only been superficially covered (Yungblut pers. comm.). Although some exploration leases are currently maintained for Foxe Basin, it is unlikely that either area will receive much attention for quite some time. However, Prince Regent Inlet and western Hudson Bay have been suggested as shipping routes for oil and gas from points further west (Stirling pers. comm.).

Problems

The major problem in Zone C is the lack of a data base for management – not only within the zone, but for all adjoining zones where boundaries are blurred by indistinct population ranges. Apart from known maternity denning areas and a few presumed summer retreats, critical areas have not been identified for this zone.

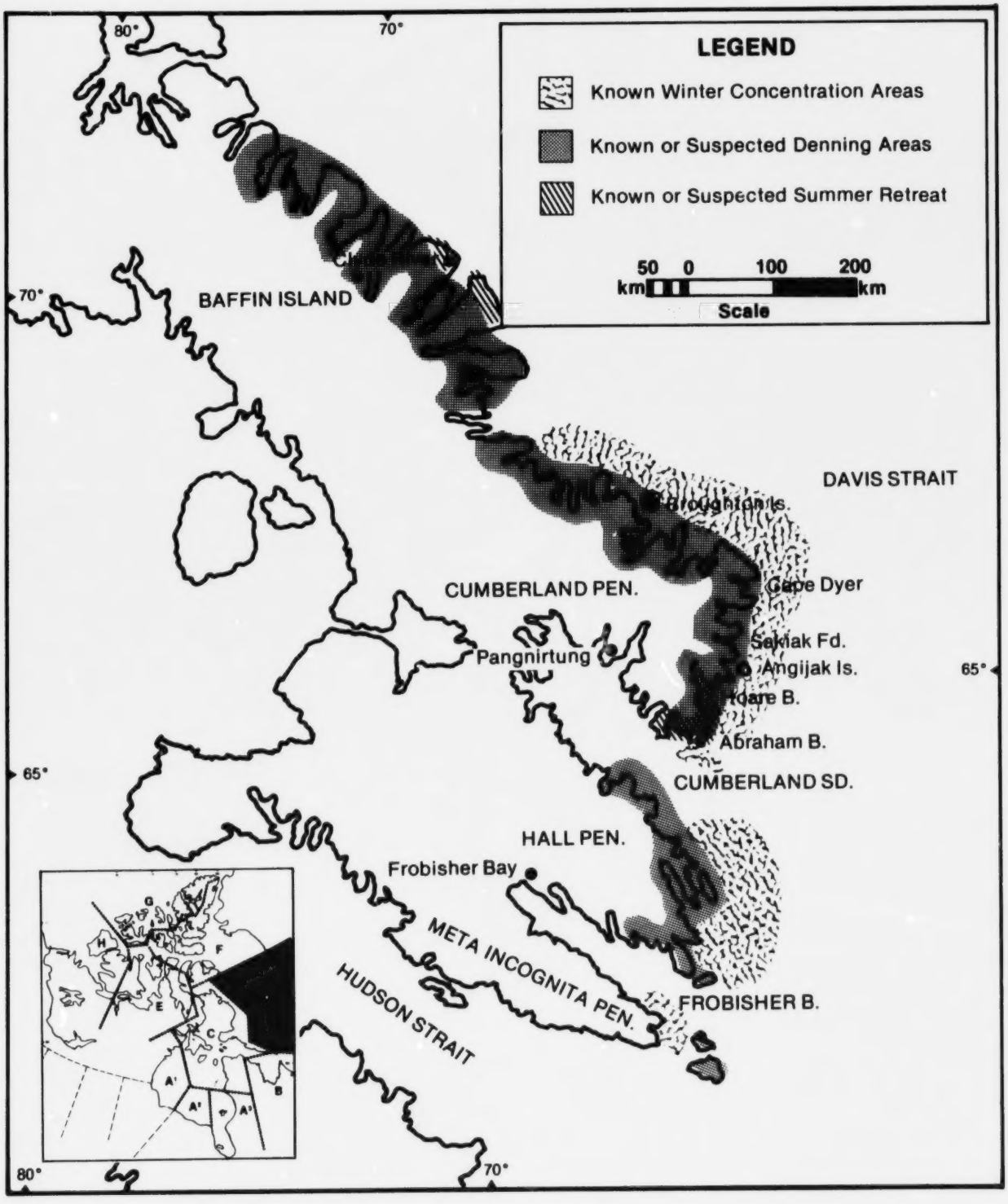


Figure 8. Zone D – East coast of Baffin Island.

ZONE D

Davis Strait, along the east coast of Baffin Island, constitutes Zone D where offshore hydrocarbon deposits may eventually be developed (Fig. 8). Much of the coastline within this zone is rugged and penetrated by numerous deep fiords. During winter, land-fast ice is confined to coastal indentations by ocean currents. South of Cape Dyer the pack ice of Davis Strait never becomes consolidated (Stirling et al. 1980).

The amount and extent of floe drift are primarily a function of winter conditions which vary from year to year. Winter temperatures are ameliorated by the proximity of large polynyas. The productivity of the marine environment off southeastern Baffin Island is somewhat enhanced by the presence of seabird colonies on offshore islands and the seaward tips of peninsulas (Stirling et al. 1980). Since 1960, the climate of the eastern Canadian Arctic has exhibited a cooling trend.

Population Status

Background

The main source of information about Zone D polar bears is provided by a mark-recapture program conducted in the southern half of the Zone* between 1974 and 1979 in which 231 animals were tagged (Stirling et al. 1980). A number of aerial and overland maternity denning surveys were performed in the same area between 1976 and 1978 (Jonkel et al. 1978). Fur auction returns from this area for the period 1975-79 have been summarized (Smith 1977, 1978, 1979; P. Smith pers. comm.).

Population Range

Mark-recapture data do not indicate extensive seasonal movements of polar bears within the southern half of this zone. Some bears may move south during winter and north during summer. The number of bears which travel offshore into Davis Strait is unknown but some of them apparently drift southward on ice floes to Labrador (Stirling et al. 1980). Those animals come ashore in spring and then move northward along the Labrador coast and across Hudson Strait, returning eventually to Baffin Island. Existing data suggest that while the proportion of the southern Zone D population covering this circuit may not be large, a much greater percentage of the bears found in Zone B may be involved in such movements. Therefore, those Zone B bears may not constitute a distinct population but only the southeastern extremity of the Zone D population, from which a few bears summer on Labrador with the rest returning to Baffin Island (or Foxe Basin).* The relationship between Zone D bears and Zone C bears on the Meta Incognita Peninsula has not been clarified and the validity of the present zone boundary dividing that peninsula is unproven.

Seasonal distribution**

During winter, bear densities were highest adjacent to the ends of the three major peninsulas (Cumberland, Hall, Meta Incognita); the greatest observed density being between Angijak Island and Cape Dyer on the Cumberland Peninsula. Densities decrease in the larger fiords (Frobisher Bay, Cumberland Sound). The preferred winter habitat of polar bears is land-fast ice. Along the southeastern Baffin coast, it is usually only a few kilometres wide, confined to bays and fiords, and it rarely projects much beyond headlands where open water or pack ice predominates. Consequently track densities in this restricted area are higher than those normally found in the Western Arctic but they do not indicate a larger population. Track densities also seemed to be quite high on the pack ice adjacent to the land-fast ice, indicating that a substantial proportion of the population frequents that area as well. Spatial segregation by sex and age class during winter on Davis Strait is unknown.

* A similar study in the north half of the zone began in 1980 and is scheduled for completion by 1985.

* A similar situation may pertain to Zones C and B in which case Zone B is actually a mixture of Zone C and D bears plus a few permanent Ungava-Labrador residents.

** Descriptions of population status unless otherwise stated are confined to Zone D south of 68°N, being the study area of the mark-recapture program (Stirling et al. 1980).

Unlike elsewhere in the Canadian Arctic, bears in this region travel extensively on land during late winter and early spring to avoid hazardous crossings of open water with strong currents or unstable ice. Family groups may also prefer land travel as a means of avoiding large male bears which only use such routes when too much open water prevents ice travel. Polar bears of southeastern Baffin Island regularly return to the same late winter and early spring feeding areas. The home range of bears during the winter and spring feeding periods is believed to be 100-150 km in diameter (Stirling et al. 1980). During summer, bears appear to be more concentrated at the ends of peninsulas and on offshore islands than elsewhere (e.g. in deep bays and fiords). Particular summer retreats have not been identified for southeastern Baffin Island.

Maternity denning

The major denning area on southeastern Baffin Island is the Cumberland Peninsula between Broughton Island and Abraham Bay (Stirling pers. comm.). Family groups, or their tracks, have been sighted throughout this broad stretch of coast but may be somewhat more concentrated in the Sakiak Fiord-Hoare Bay region (Stirling pers. comm.). The seaward tip of Hall Peninsula is also a maternity denning area, although apparently of less importance (Stirling et al. 1980). A few sightings of family groups or tracks have also been recorded for Meta Incognita Peninsula. Maternity dens in this region are vacated by mid-April (Stirling et al. 1980).

Numbers

From mark-recapture data, an estimate of the polar bear population on the southeastern coast of Baffin Island in 1979 was 500, for a presumed survival rate of 0.87 (Table 9).* A higher figure was obtained by adding separate estimates for each of the major peninsulas, but recognition of the biases in both methods has resulted in a subjective compromise of 700+ animals for the whole area. This figure does not include the additional (and unknown) offshore contingent of the population but is still a fair indication of the size of the "hunted" population in the southern half of the zone, upon which harvest quotas are based.

Generally, the number of bears on Cumberland Peninsula is about double that of Hall Peninsula, and presumably even greater than the local population of Meta Incognita Peninsula for which there is no separate estimate. There is no estimate of the total population of Zone D.

Table. 9. Estimates of the polar bear population along the southeastern coast of Baffin Island (Stirling et al. 1980).

	Population Estimates			
	Survival rate 0.87		Survival rate 0.80	
Area	1978	1979	1978	1979
Hall Peninsula	206	234	180	195
Cumberland Peninsula	761	477	675	415
Hall and Cumberland Peninsulas	967	711	855	610
Total area (independent)	726	500	641	436

Productivity and Mortality

The majority of females in southeastern Baffin Island conceive for the first time at age four (Table 10), which is the same as in the High and Central Arctic regions of Canada, but a year earlier than in the Western Arctic and Alaska (Stirling et al. 1980). The natality rate of adult females (age 5-26) was 0.541, which is higher than other areas but may be partly due to sampling bias and partly to the higher mean litter size for cubs of the year (1.81).* Female polar bears in the southern half of this zone are believed to breed at three-year intervals (Stirling et al. 1980).

Mortality rates for all sex and age classes examined were substantially higher than the values for female bears elsewhere in the Canadian Arctic (Table 11), and although they are suspected of being inaccurately high, they are still believed to indicate higher actual mortality than in other areas.

* Based on a range of 0.86-0.90 for bears in other areas.

* An earlier estimate of this index was 1.6 (Jonkel et al. 1978).

Table 10. Summary of productivity analyses for polar bears of southeastern Baffin Island (Stirling et al. 1980).

Age class of females (yrs)	Litter-produced rate (no. of females)	Mean litter size (no. of females)	Natality rate
3	0.031(32)	1.00(1)	0.031
4	0.286(28)	1.75(8)	0.501
5	0.167(18)	1.00(3)	0.167
6-9	0.320(75)	1.75(24)	0.560
10-14	0.263(19)	2.00(5)	0.526
15-19	0.143(7)	3.00(1)	0.429
20-26	0.333(6)	1.50(2)	0.500
5-26	0.299(107)	1.81(32)	0.541

Table 11. Sex-specific mortality rates of capture samples from the polar bear population of southeastern Baffin Island (Stirling et al. 1980).

Sex	Age class	Annual mortality rate
Male	0-19	29.7
Male	2-19	31.7
Female	0-19	20.7
Female	2-19	23.2
Female	5-19	27.3
Male and female	0-19	22.1
Male and female	2-19	23.6

N.W.T. Renewable Resources

The preferred winter habitat of polar bears is land-fast ice.

Utilization

Polar bears are hunted by four settlements in Zone D. Although harvest data are incomplete, an eleven-year summary (1968-1979) of the known kill for the southern half of the Zone indicates that more males are taken than females, but that for the latter sex, younger adults with the greatest reproductive potential predominate (Table 12) (Stirling et al. 1980). This may be related to the combined effects of the spatial segregation of polar bears plus Inuit hunting patterns, resulting in the selection of young females with cubs as opposed to older unaccompanied females. Another possibility is that the population is being overhunted.

Table 12. Age structure of the southeastern Baffin Island polar bear population based on kill statistics (1968-79) and capture data (1974-79) (Stirling et al. 1980).

Age	Number of bears Killed Male	Killed Female	Captured* Male	Captured* Female
0	2	3	33	29
1	4	7	8	3
2	16	8	11	6
3	10	13	11	11
4	17	14	11	13
5	11	7	8	19
6	4	6	6	9
7	5	5	6	9
8	1	4	6	12
9	2	1	6	7
10	7	1	6	4
11	1	—	3	2
12	2	2	1	3
13	2	2	1	4
15-26	9	1	9	8
A Total aged	93	74	126	139
B Unaged	120	65	1	—
A + B	213	139	127	139

* Includes age at time of recapture of bears originally marked in other areas.

As in other parts of the Northwest Territories, bears are hunted in this zone mainly for the commercial value of the hide, and a few are used for subsistence (meat, sleeping robes). Average hide prices paid to each settlement generally increased over the years 1976-77 to 1978-79, except for a large decrease in the 1978 value of hides received from Broughton Island (Table 13). Sport hunting was offered for the first time in this zone by the residents of Allen Island outpost camp in 1979-80. Four non-resident hunters participated that year, of whom one was successful. The cost per hunt was $10,500. (Freeland pers. comm.). Defense-kills are not common in this zone, possibly because the larger communities are not located within high density polar bear areas and industrial activities have so far been limited.

Industrial Activity

The first offshore well was drilled in Davis Strait by Imperial Oil Ltd. in 1979. Although oil-bearing sands were discovered at that site, further work was discontinued in 1980 but will be resumed once areas off the Newfoundland coast have been more fully explored (Yungblut pers. comm.). The presence of petrochemical deposits in Davis Strait will likely intensify future exploration activity in the area, and may eventually lead to the development of oil and gas fields.

Table 13. Summary of polar bear utilization in Zone D, 1976-77 to 1978-79 (Smith 1977, 1978, 1979; P. Smith pers. comm.).

	Quota			Known kill			Average hide price paid to hunters in $ (no. of hides)		
Settlement	1976	1977	1978*	1976	1977	1978	1976	1977	1978
Broughton Is.	16	22	22	14	21	14	644(16)	686(22)	523(15)
Clyde River	42	42	42	33	43	42	592(34)	672(37)	815(40)
Frobisher Bay	12	18	18	8	18	13	500(1)	791(13)	982(17)
Pangnirtung	14	14	14	14	14	14	677(13)	589(13)	1421(11)
Total	84	96	96	69	96	83	$39,733	$57,896	$72,770

* No red tags allotted in 1978 to this zone.

Problems

Existing population and harvest data, while admittedly incomplete, do suggest that in the southern half of Zone D, the hunted segment of the polar bear population is either being used to full capacity or is in danger of being over-harvested. It also appears that a disproportionate number of young adult females are being taken. Without accurate knowledge of the entire population, including those bears which winter on the pack ice, it is difficult to determine the sustained yield potential of the zone.

The relationship between bears of Zones D, C and B seems complex but remains obscure. Management policies which rely on existing zone definitions in this area may therefore be prone to substantial errors until it is clear which bears are being hunted by which settlements. The apparent discreteness of the southeastern Baffin Island population may be correct within the area covered by the mark-recapture program but leaves gaps at both ends.

The location of maternity denning areas and summer retreats are so far not defined with sufficient accuracy for designation as "critical wildlife areas." However, the apparently broad distribution of such areas, at least in the southern half of the zone, may preclude the need for such protection.

The concentration of bears in winter as a result of habitat restrictions creates the erroneous impression of abundance which in reality does not exist.

As a result, quota levels are considered by local residents to be ultra-conservative because circumstantial evidence convinces them that a much greater harvest could be sustained.

The likelihood that a significant proportion of bears found in Zone B are actually produced in Zone D may eventually lead to inter-jurisdictional disputes over hunting rights.

The eventual occupation of Davis Strait by petrochemical exploration and production enterprises will inevitably result in the increase of man-bear conflicts, and may endanger polar bears directly or through habitat destruction in the event of an industrial disaster.

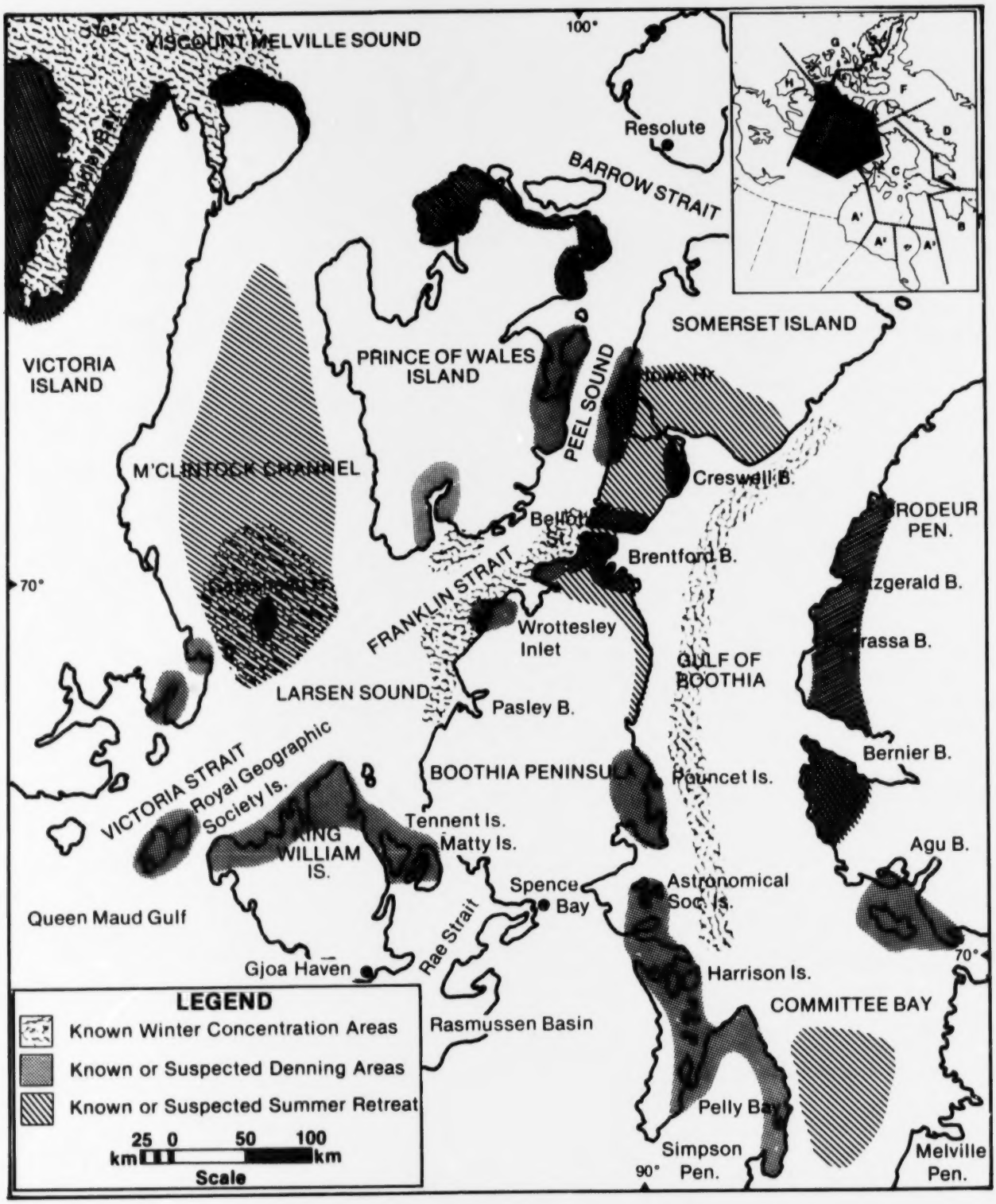


Figure 9. Zone E - Central Arctic.

ZONE E

This zone covers the Central Arctic from the eastern portion of Victoria Island in the west to Melville Peninsula in the east (Fig. 9). It is a region of relatively isolated bodies of water, confined by numerous large and small islands plus the mainland. Its remoteness from the warming influences of air and ocean currents results in the year-round retention of sea ice in many locations. The only known recurrent polynya of any significance is in Bellot Strait (Stirling et al. 1978). All those factors influence the status of polar bears to the effect that relationships among bears of various regions within the zone are quite complex, and seasonal movements are largely undocumented. Still, more is known about bears in this region than in many other parts of the Canadian Arctic, because of the length and intensity of research programs completed there and in adjacent areas to the west and north.

Population Status

Background

A mark-recapture program was initiated in 1972 and expanded after 1975 because of a proposal to construct a gas pipeline across the zone.*

In total, 454 bears were captured between 1972 and 1978 (Stirling et al. 1978, Schweinsburg et al. 1981). Maternity denning surveys were conducted by helicopter and snowmobile. Additional data accrued from concurrent mark-recapture studies in Zones F (Schweinsburg et al. 1980) and H (Stirling et al. 1975). Other sources are hunter reports, specimens from harvested bears, Wildlife Officer reports, and summaries of fur auction returns (Smith 1977, 1978, 1979; P. Smith pers. comm.).

Population range

The relationship between bears in this zone may be more complex than in most zones, owing to the restrictions on movements imposed by land barriers and ice conditions. The entire known range of bears marked in this zone is north to approximately 73°, south to about 68°, east to Baffin Island and Melville Peninsula, and west to Victoria Island. Within this area there may be a division between bears north and south of Creswell Bay as a result of the early spring break-up. This forces bears to move either north or south to separate summer retreats and establish female (and cub) home ranges with little or no overlap. A second separation, between the bears of Franklin Strait and the northern part of Peel Sound, was apparent between 1972 and 1976, but may not be a permanent condition since numerous tracks were observed in Peel Sound in the spring and summer of 1977 and 1978 (Schweinsburg et al. 1981).

No exchange was recorded between bears of Hadley Bay and M'Clintock Channel, but this may be because little tagging was done in the latter area. From hunter reports and reconnaissance surveys it was concluded that very few bears occupy Queen Maud Gulf, Rae Strait, and Rasmussen Basin. Also, none of the total 982 bears tagged in Zones E and H have ever been recovered in the other zone, increasing the possibility that the two populations are discrete.

Based on the preceding observations and conclusions, four sub-populations have been tentatively identified for this zone (Schweinsburg et al. 1981). The distribution of the sub-populations may be summarized as follows:

1) Franklin Strait, Larsen Sound, Bellot Strait, Brentford Bay, and the north end of the Gulf of Boothia.
2) The south end of the Gulf of Boothia.
3) Victoria Strait and the south end of M'Clintock Channel.
4) Hadley Bay, Wyniatt Bay, and the southern edge of Viscount Melville Sound.

Exchanges between any two of those sub-populations were not more than 10%, qualifying each for sub-population status (according to the currently accepted definition of such inter-relationships). The degree of interaction among bears of Committee Bay, Gulf of Boothia, and Foxe Basin at the eastern perimeter of this zone remains unclear (Schweinsburg et al. 1981). Elsewhere, exchanges between bears of other zones and this one have not occurred.

* The proposal has since been shelved in favour of another route.

While the discreteness of sub-populations is valid within the definition of limited exchange, it is possible that in some areas (e.g. Hadley-Wyniatt Bays), the concentration of sampling effort has resulted in range distortions by creating artificial boundaries and gaps between sub-populations, where there is actually a continuum of bears that were not sampled (Stirling et al. 1978). In other areas, of course, the separation between populations, especially by land barriers or ice conditions, is more likely.

Seasonal distribution

Most polar bears in this zone appear to return to the same areas each spring, but whether they demonstrate similar seasonal fidelities to other areas during the rest of the year is unknown. Track patterns suggest that some routes may be used in spring by a number of bears moving between areas of concentration, but well-defined spring migration routes generally do not seem to exist in this zone (Stirling et al. 1978). Bears from Franklin Strait appear to vacate that area in spring in the direction of M'Clintock Channel and possibly Barrow Strait (Schweinsburg et al. 1981).

Throughout the zone most bears remain on the ice as long as possible, and in doing so eventually become concentrated near small islands and along indented coastlines where break-up is prolonged (Stirling et al. 1978). It is suspected that many bears may pass the entire summer in areas where ice remains throughout the year, such as M'Clintock Channel and Committee Bay (Schweinsburg et al. 1981). Known major summer retreats in this zone are southern Somerset Island and northeastern Boothia Peninsula (particularly Brentford Bay). Other possible summer retreats are the west coast of Brodeur Peninsula, northern Prince of Wales Island, and Hadley Bay (Schweinsburg et al. 1981).

Fall and winter distributions of bears in this zone are unknown but, as elsewhere in the Arctic, animals probably move onto the new ice in October and remain there all winter – except for those which den on land.* Concentrations may develop in particular areas during the winter in association with seal accessibility or other factors, but so far they are unknown.

Maternity denning

The location and relative importance of most maternity denning areas in this zone are based on circumstantial evidence, such as the proximity of females and cubs or their tracks during the period of den emergence. Occasionally dens are actually found, such as at Gateshead Island, which is a major denning area in the zone with one of the highest den densities in the archipelago (Spencer and Schweinsburg 1979).

Denning areas in this zone may be generally grouped into three categories:

1) **Known denning areas:** Simpson Peninsula, Harrison Islands, Boothia Peninsula (north end, east coast – especially Pouncet Island area) and Bellot Strait, Matty, Tennent, King William and Royal Geographical Society Islands, Prince of Wales Island (north coast-low density), Wyniatt and Hadley Bays, Gateshead Island, and southern Somerset Island.

2) **Suspected denning areas:** Prince of Wales Island (east coast), Somerset Island (McClure Bay-Howe Harbour), Brodeur Peninsula (entire west coast including bottom of Bernier Bay and Bourassa Bay-Fitzgerald Bay).

3) **Inadequately surveyed areas:** Prince of Wales Island (west coast and central parts of the east coast), Somerset Island (northeast and northwest coasts), Boothia Peninsula (west coast), Brodeur Peninsula (Bourassa Bay-Fitzgerald Bay).

The small remainder of this zone is considered to be unsuitable for denning.

From existing data, maternity denning seems to be a broadly distributed activity with few areas of concentration. This has been ascribed to the apparent availability of unlimited denning habitat for the number of bears in the zone. However, it is also possible that major concentrations have been missed or not covered by surveys done thus far.

* There is no known instance of maternity denning on the ice in the Canadian Arctic (Stirling et al. 1978).

Numbers

Estimates for the total polar bear population of Zone E in 1977 and 1978 were 1049 and 1478 respectively (Schweinsburg et al. 1981). The difference between estimates does not indicate a population increase but is more a measure of data reliability. Thus an average of estimates from 1974 to 1978 of 1060 bears is a better approximation but is probably low because neither tagging samples nor bear distributions are random. The best estimates for sub-populations 1, 2, 3, and 4 were 442, 333, 305 and 140 respectively (Table 14).

The sum of the first three sub-populations (excluding Hadley Bay) is 1080 which compares well with the five-year average for the same portion of the zone (1100). The figure of 1100 bears for the zone (excluding Hadley Bay) is used in productivity analyses and considered a conservative population estimate of that area for management purposes.

Table 14. Summary of population best estimates for Zone E, 1974-78 (Schweinsburg et al. 1981).

Area or range	Estimate	Standard error	Year
Sub-population 1	442.12	73.6	1977
Sub-population 2	333.90	122.62	1978
Sub-population 3	305.79	240.06	1974-77(aver.)
S1 + S2 + S3	1080.81	436.28	
Sub-population 4	140.97	73.41	1974-76(aver.)
Zone E (including* Hadley Bay)	1217.28	412.07	1974-78(aver.)
Zone E (excluding** Hadley Bay)	1060.30	515.34	1974-78(aver.)
Zone E (management use - 5 year average)	1100	N/A	1980

* Separate calculations - not the sum of sub-populations (in table).

** Calculations exclude Hadley Bay bears since their affinity with the rest of the Zone E population is not certain.

Productivity and mortality

The overall mean litter size for the population of Zone E was 1.56 ± 0.06 (SE) cubs/litter for 1972-78 with 50.3% of all adult female bears being accompanied by cubs (Schweinsburg et al. 1980). There was no significant difference among the mean litter sizes for age groups up to age two in this zone. Some mortality prior to weaning at age two-and-a-half is implied from a gross comparison of mean litter size for cubs of the year (1.64 ± 0.08 SE), yearlings (1.44 ± 0.10 SE) and two-year olds (1.43 ± 0.14 SE) (Schweinsburg et al. 1981). In this zone female bears breed in the spring of their fourth year and cease to be reproductive beyond the age of 20 (Table 15). Natality rates computed for the zone until 1978 indicate a population with a strong recruitment potential, assuming average juvenile mortality rates. It is estimated (by multiplying female age class frequencies by weighted mean natality rates) that about 152 cubs are born yearly in Zone E (Schweinsburg et al. 1981).

A mortality rate of 8% was calculated for the entire Zone E population (Schweinsburg et al. 1981). Hence, each year 88 out of 1100 bears die; and of those, 53 are harvested (as of 1977), and 35 are claimed by natural mortality factors.

Although male bears predominate in the harvest, it is evident from the balanced sex-ratio of the overall population (taken from the capture sample) that the degree of selectivity in hunting is insignificant to the status of bears in the zone (Table 16). The age distribution of this population is assumed to be stationary due to: a) the long-term residency of the zone's bear population; b) the absence of major environmental changes in recent history; c) constant human predation since 1967; d) no observable change in the abundance or distribution of bears in traditional and recorded history (Schweinsburg et al. 1981).

The presence of older bears in both the kill and capture samples also indicates that the Zone E population was not being over-hunted between 1972 and 1978.

Table 15. Summary of polar bear productivity in Zone E, 1972-78 (Schweinsburg et al. 1981).

Age class of females (yrs)	Number	Probability of parturition*	Litter size*	Natality rate*
3	19	0	0	0
4	14	0	0	0
5	15	0.31	1.33	0.41
6	24	0.18	1.57	0.28
7	15	0.24	1.50	0.36
8	10	0.56	1.73	0.97
9	8	0.36	1.25	0.45
10	3	0.13	1.67	0.22
11	5	0.45	1.89	0.85
12	6	0.18	1.00	0.18
13	11	0.21	1.67	0.35
14	3	0.20	2.00	1.00
15	2	0.50	2.00	1.00
16	0	1.00	1.67	1.67
17	3	0.40	2.00	0.80
18	2	0.25	1.00	0.25
19	2	0.50	1.33	0.67
20	2	0.40	1.33	0.53
21-30	9	0	0	0
Overall weighted mean		0.287	1.527	0.438

* Age specific

Table 16. Age structure of the Zone E polar bear population based on kill statistics (1967-77) and capture data (1972-78) (Schweinsburg et al. 1981).

	Number of bears			
	Killed*		Captured*	
Age	Male	Female	Male	Female
0	0	0	33	24
1	3	4	17	27
2	15	2	26	23
3	15	7	14	22
4	7	6	22	16
5	6	4	20	16
6	2	2	19	23
7	3	7	25	19
8	5	2	7	15
9	2	1	11	7
10	3	3	11	7
11	2	0	7	8
12	1	0	9	6
13	0	1	8	11
14	2	1	7	3
15	0	2	4	1
16	0	1	6	0
17	2	0	3	4
18	0	0	1	2
19	1	1	1	2
20	0	0	3	2
21	0	3	5	3
22	0	1	1	1
23	0	1	2	1
24	1	1	2	2
25-29	0	1	0	2
Total	70	51*	264	247

* Only bears which have been aged are given. The actual total harvest over the 10-year period is greater.

Table 17. Summary of polar bear utilization in Zone E, 1976-77 to 1978-79 (Smith 1977, 1978, 1979; P. Smith pers. comm.).

Settlement	Quota				Known kill*			Average hide price paid to hunters in $ (no. of hides)		
	1976	1977	1978		1976	1977	1978	1976	1977	1978
			Reg. tag	Red tag						
Arctic Bay*	—	—	—	—	—	?	4	—	?	1750(24)
Cambridge Bay	10	10	10	5	10	7	13	645(10)	?	?
Gjoa Haven	9	9	9	5	8	9	15	?	?	1161(11)
Hadley Bay**	?	?	4	—	?	?	0	?	?	—
Pelly Bay	10	10	10	5	10	13	15	?	?	?
Spence Bay	22	22	22	5	21	22	26	?	633(13)	?
Igloolik***	—	—	—	—	—	?	9	—	?	?
Hall Beach +	—	—	7	—	?	?	1	?	?	?
Resolute Bay@	—	—	—	—	1	?	4	?	413(2)	947(21)
Total	51	51	82		50	51	87	$6450	$9055	$23,559

* Quota assigned to Zone F since most bears are hunted there.
** Outpost camp. Until 1978 quota was taken from Cambridge Bay.
*** Quota assigned to Zone C where most bears are hunted. Average taken from this zone between 1968 and 1978 = 4.
\+ Quota assigned to Zone C.
@ Quota assigned to Zone F.
? no data
— no success or no quota

Utilization

Until 1978, about 53 bears were harvested annually from this zone.* After the quota increase in that year, 89 bears (Table 17) were taken in the following season (1978-79).* Hunting areas for each settlement, described on the basis of reported kills, are located as follows (Schweinsburg et al. 1981):

1) Pelly Bay - Harrison Islands, Simpson Peninsula
2) Spence Bay - Harrison Islands, Royal Astronomical Society Islands, southeast coast of Boothia Peninsula, southwest coast of Boothia Peninsula to Pasley Bay, Matty and Tennent Islands. Also a few bears from: south end of Prince of Wales Island, Tasmania Islands, Bellot Strait-Creswell Bay area.
3) Gjoa Haven - East and north coasts of King William Island, Astronomical Society Islands.
4) Cambridge Bay - Victoria Strait, M'Clintock Channel, Gateshead Island, Hadley Bay.
5) Resolute Bay - Creswell Bay
6) Arctic Bay - Bernier Bay
7) Igloolik - Agu Bay, Kimakto Peninsula.

Overlap between the hunting area of Spence Bay and those of Pelly Bay, Gjoa Haven and Resolute Bay is apparent from the above description. Otherwise, hunting areas are separate, although this may be partly a result of incomplete hunter kill data.

* Including defense-kills.

An analysis of hunting success versus season for the period 1968-1977 indicated that in recent years many bears were taken in autumn by hunters of Gjoa Haven, Spence Bay, and Pelly Bay. Only the latter settlement actually killed more females in autumn than spring (Schweinsburg et al. 1981). Since 1978, the hunting season has been restricted to 1 December to the following 31 May primarily to protect denning family groups and pregnant females.

Sport hunting on a limited scale has been offered intermittently by Cambridge Bay since 1975. Otherwise, bears are hunted primarily for the commercial value of their hides but may also be used for subsistence (meat, robes), especially in outpost camps.

Industrial Activity

Exploration for hydrocarbons in Zone E has been confined to land surveys. The discovery of natural gas in the High Arctic* led to a proposal from Polar Gas in 1974 to construct a 46-inch gas pipeline (known as the Arctic Islands Gas Pipeline) from the Sverdrup Basin across the zone to southern Canada (Stirling et al. 1978). This proposal spawned a number of environmental impact assessments and, for a time, field research in the area intensified (1975-1977). Since then, another route across Victoria Island (see Zone H) seems to be preferred, and industrial interest together with related ecological studies have subsided. Thus, it would seem that the only impact by industry on the marine environment to date has been from the research generated. Since results from land exploration have so far been negative and an alternate pipeline route seems to be favoured, future industrial activity in this area, particularly as it affects the marine environment, is likely to be very slight. Tanker traffic associated with Bridport Inlet, Melville Island, would also have very little contact with bears from this zone.

* First well, Dome Petroleum - King Christian Island 1962 (Ebert pers. comm.).

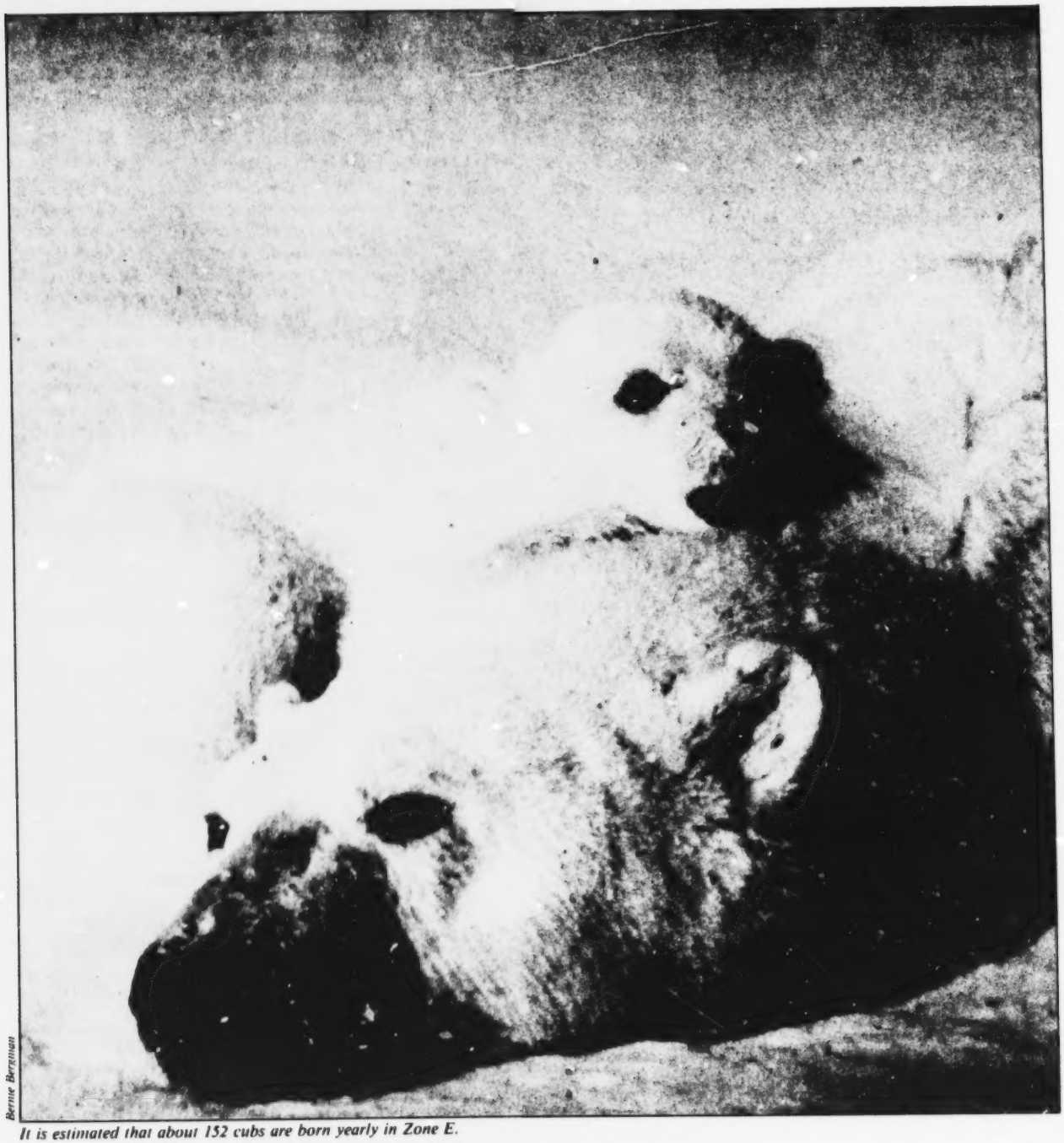
Problems

Apart from the common difficulties associated with all polar bear management and research, this zone has few special problems, especially since the apparent abandonment of the originally proposed pipeline route across it. Ideally, bears should be managed on a subpopulation basis, but the time and costs of current monitoring techniques preclude that luxury. As long as the relationship between bears of Zone E and C remains unknown, management will be considerably hampered in that area. Lack of data for M'Clintock Channel is also a detriment to effective management. The broad distribution of maternity denning areas and summer retreats affords some immunity from disturbance for sub-populations of this zone, yet areas of known or suspected major importance (Gateshead Island, M'Clintock Channel, Committee Bay) should receive legal protection.

The currently proposed pipeline route just nips the extreme northwestern tip of this zone and activities associated with its construction and maintenance would have a minimal effect on the Zone E population. Hazards to bears from either route would primarily result from man-bear conflicts (especially during the construction phase), disturbance of maternity denning, and the consequences of an industrial disaster. So far none of these potential problems have been adequately dealt with anywhere in the Canadian Arctic.

Current delineations of sub-populations, while useful for quota assessments, are not reliable references for the evaluation of industrial impacts, since some of the boundaries may be the result of sampling effort. Hence they do not indicate the true identity of certain sub-populations or the apparent existence of unpopulated areas. Site-specific industrial activities in such obscure regions must therefore be preceded by additional field studies.

A conflict between the communities of Spence Bay and Gjoa Haven has arisen from the overlap of their hunting areas. Also the present allocation of quotas to some settlements (Igloolik, Hall Beach, Resolute) is inaccurate since the kill is recorded as having come from other populations in Zones C and F whereas they were actually located within Zone E. Such methods hinder the adjustment of quota levels to the sustained yield capacity of specific populations.



Bernie Bergman

It is estimated that about 152 cubs are born yearly in Zone E.

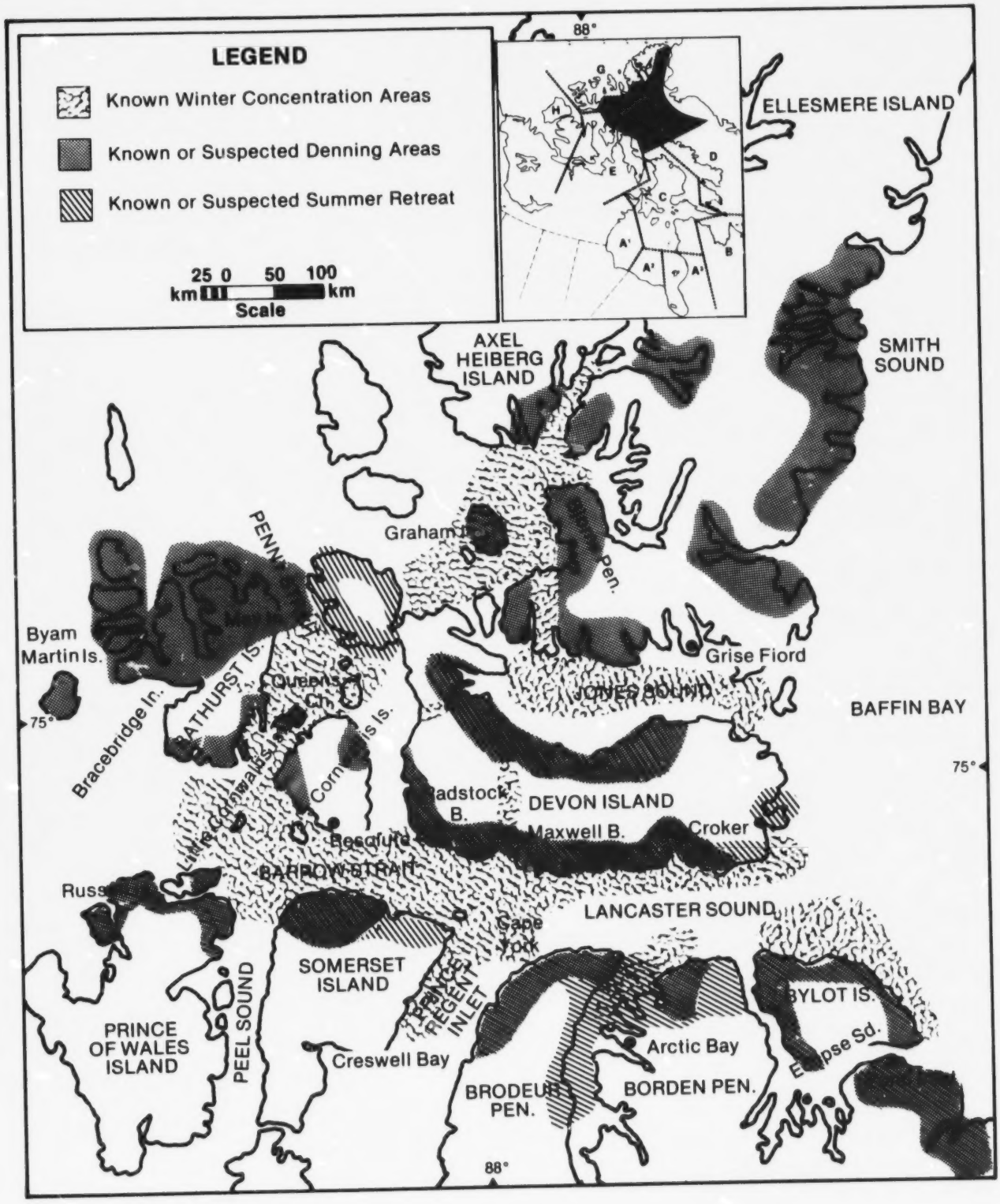


Figure 10. Zone F – High Arctic.

ZONE F

All the waters from Baffin Bay across to Barrow Strait and north to Alert (northern tip of Ellesmere Island) are combined in this High Arctic zone which contains the eastern half of the Northwest Passage – a region of relatively high polar bear density and particularly high industrial potential (Fig. 10).

The pattern of ice movements in this zone is complex, and seasonal ice conditions are regionally variable. In the west, most channels are completely ice bound during winter except for polynyas which form in Lancaster Sound, Barrow Strait, Bellot Strait, Penny Strait and Queens Channel (Stirling et al. 1978). Further east, Lancaster Sound forms a western arm of the Northwater – the largest polynya in the Canadian Arctic, encompassing Smith Sound and northeastern Baffin Bay (Stirling 1980). By mid-August Lancaster Sound, most of Barrow Strait, northern Peel Sound, and Prince Regent Inlet are ice free (Stirling et al. 1978).

Surface water currents are generally weak and flow in southerly or easterly directions (Schweinsburg et al. 1981). The Arctic Ocean to the northwest is the main source of those currents, which become deflected or form eddies in Lancaster Sound where they meet the warmer counterflow from Baffin Bay (Stirling et al. 1978). The steep shoreline topography of this zone funnels and accelerates winds through the ocean channels in either direction depending upon the local combination of climatic factors (pressure systems, polynyas, catabatic winds) (Schweinsburg et al. 1980). Productivity of the marine environment varies from low along the northwest boundary of the zone to high in Lancaster Sound, which accumulates nutrients from upwelling bird guano and glacial runoff (Schweinsburg et al. 1980). In general, the climate shifts from arctic maritime in summer to arctic continental in winter as the areas of open water gradually become ice covered (Schweinsburg et al. 1980).

Population Status

Background

Early biological investigations of this zone in 1958 (Manning and MacPherson 1961) and 1961 (Tener 1963) recorded observations of polar bears. A preliminary polar bear survey was conducted in the Resolute Bay area in 1962 (Harington 1963), and in 1970 a general study of polar bears in the High Arctic, based out of Resolute, was undertaken (Jonkel 1976). Between 1971 and 1980 approximately 770 bears were marked in this zone (Stirling et al. 1978, Spencer and Schweinsburg 1979). Ground and aerial maternity denning surveys have been conducted intermittently over the past 10 years. Other sources of information are harvest data and summaries of fur auction sales (Smith 1977, 1978, 1979; P. Smith pers. comm.).

Population range

Taken as a whole, the bears of Zone F appear to have little connection with those of Zone E. The early spring break-up in the vicinity of Creswell Bay divides bears north and south of that area.

Little is known of the bears in northern M'Clintock Channel and thus the division between Zones E and F across Viscount Melville Sound is not substantiated. Bears from Hadley Bay to the west do not enter Barrow Strait and it is presumed that the bears of northeastern Victoria Island (Zone E) are distinct from those of Barrow Strait (Zone F) (Stirling et al. 1978). Nothing is known of the relationship between the populations of Zones F and G. Mark-recapture data indicate a significant connection among bears which extends from Lancaster Sound to northeastern Baffin Island at least as far as Clyde River (Zone D) and possibly beyond to Cape Dyer (Schweinsburg et al. 1980). Two bears from Zone F have been killed in Greenland and it is likely that the Zone F population, particularly the eastern portion, is shared with that country. There are no data on polar bear movements north of Grise Fiord since none of the studies have covered that area.

Within Zone F the ranges of sub-populations are poorly defined despite the comparatively large number of bears marked there. This may be due to inconsistent sampling effort over the years but may also be the result of extensive mixing caused by ocean currents carrying ice floes (with bear passengers) through Barrow Strait, Prince Regent Inlet, Lancaster Sound, Baffin Bay, and Jones Sound during the summer. The distinction of sub-populations is not possible as yet for Zone F and may not exist in actuality.

Seasonal distribution

Movements of bears between winter and summer, determined from mark-recapture studies in the western half of the zone, displayed no strong directional patterns, although a general northward shift in summer and a reverse trend in winter were apparent (Stirling et al. 1978). Seasonally directed movements are likely to be peculiar to each bear within its own home range and thus tend to cancel each other when combined for larger areas (Stirling et al. 1978). During summer bears become concentrated in bays where ice cover is prolonged. The coast of southern Devon Island (particularly Radstock and Maxwell Bays) is a preferred summer retreat for this reason (Schweinsburg et al. 1980).

During the late winter periods of 1978 and 1979, bears were more concentrated near the south Devon coast than the northeast Baffin region. In both areas about two-thirds of observed bears were on the landfast ice and the remaining third at the floe edge (Schweinsburg et al. 1982). Inshore areas are avoided by all except females with cubs of that year who have emerged from their dens in March and April. As summer progresses, bears in the southwest of Zone F may seek land or areas of permanent ice, while others remain adrift on ice floes (Schweinsburg et al. 1982). Variable ice conditions from year to year likely influence the proportion of bears in each summer habitat and the duration of its occupancy. Summer snow dens have been found on the northern Baffin Island and Bylot Island. Bears occupying those dens were noticeably more alert and restless than those in winter dens and apparently more vulnerable to disturbance such as helicopter overflights (Schweinsburg 1979). It has also been suggested that some male bears may travel farther inland to excavate summer dens on the Bylot Island ice cap (Jonkel 1976). In Lancaster Sound, summer retreats on land and fast-ice are preferred by females, cubs, and subadult males, while adult males tend to remain on ice floes and a few may den on ice caps (Schweinsburg et al. 1980).

Autumn movements within the zone are poorly understood but it may be assumed that bears return to the ice as soon as possible from their summer retreats, except for females which dig maternity dens in coastal snowbanks.

Movements of bears in Lancaster Sound may be longer on the average than those of bears elsewhere because the ice floes are carried farther by strong currents (Schweinsburg et al. 1981). Existing data are inadequate to describe the seasonal distributions and movements of bears in the northern half of Zone F.

Maternity denning

Maternity denning areas in this zone may be categorized as follows:

a) **Known areas:** north coast of Prince of Wales Island and the east half of Russell Island (Stirling et al. 1978); Croker Bay, Cape York, Radstock Bay, Bylot Island, and the north coast of Devon Island (Schweinsburg et al. 1980).

b) **Low density areas:** southeast coast of Bathurst Island, Cornwallis Island and Little Cornwallis Island, and the north coast of Somerset Island (Stirling et al. 1978).

c) **Possible denning areas:** Byam Martin Island, northern Bathurst Island, the east side of Ellesmere Island, the northwest coast of Brodeur Peninsula, Graham Island, Bjorne Peninsula and the south coast of Axel Heiberg Island (Stirling et al. 1978).

In general, maternity dens are broadly dispersed at low densities, apparently because of the large amount of suitable habitat in this zone (Schweinsburg et al. 1980). Maternity denning has not been investigated on the south and east coasts of Ellesmere Island.

Numbers

Population estimates for Zone F (Table 18) are derived from non-uniform sampling methods; thus all are suspected of being low, except for the 1979 estimate of 1031 for eastern Lancaster Sound, which seems unusually high for the sample area (Schweinsburg 1980). Still, this figure is the most accurate of the estimates produced for that region (Schweinsburg et al. 1980). Combined data from separate population studies yielded a total estimate of 1647 bears for Zone F in 1979 (Table 18).

Table 18. Population estimates for Zone F, 1976-79.

Area	Estimate	Standard error	Year	Source
West of Brodeur Peninsula	1675	451.2	1977	(Stirling et al. 1978)
Eastern Lancaster Sound	464	416.7	1977	(Schweinsburg et al. 1980)
"	2380	1695.8	1978	"
"	1031	236.3	1979	"
Entire zone	1716	445.9	1977	"
"	2802	1031.1	1978	"
"	1647	290.4	1979	"

The sex ratio of all bears captured in Zone F between 1970 and 1979 was 1:0.8 in favour of females (Table 19). This imbalance may be due to biased sampling methods prior to 1974 or to concentrated hunting pressure on male bears. The sex ratio of bears captured only in eastern Lancaster Sound was 1:1, as was the sex ratio of cubs of the year from both areas (Schweinsburg et al. 1980).

Table 19. Age structure of the Zone F polar bear population based on kill statistics (1970-78) and capture data (1970-79) (Schweinsburg et al. 1980).

Age	Number of bears Killed Male	Killed Female	Captured Male	Captured Female
0	0	1	54	55
1	11	8	21	28
2	16	23	21	30
3	36	12	19	21
4	25	17	28	31
5	37	12	19	28
6	17	7	24	20
7	15	6	21	14
8	11	11	13	26
9	14	1	10	21
10-25 +	32	19	68	101
Total	214	117	298	375

Productivity and mortality

Most female bears in Zone F breed for the first time at age four but a few in Lancaster Sound mated a year earlier (Table 20) (Schweinsburg et al. 1980). Cub production from an initial population of 1647 bears was calculated to be 172 bears annually. The weighted mean natality rate for Zone F over a nine-year period (1970-1979) was 0.336 cubs/female/year, but this figure is probably low since 40% of the data were obtained during 1978 and 1979 – a period of decreased production in the region (particularly in Lancaster Sound; natality rate = 0.217 for 1978-1979) (Schweinsburg et al. 1980). The longevity of both male and female bears in this zone is somewhat greater (25% over 10 yrs. of age) than in other arctic regions.

Table 20. Summary of polar bear productivity in Zone F, 1970-79 (Schweinsburg et al. 1980).

Age class of females (yrs)	Probability of parturition	Litter size	Natality rate
4	0.05	1.40	0.07
5	0.23	1.42	0.33
6	0.18	1.38	0.24
7	0.20	1.89	0.38
8	0.26	1.50	0.38
9	0.32	1.59	0.52
10	0.24	1.57	0.38
11-14	0.28	1.89	0.53
15-18	0.21	1.44	0.30
19-24	0.16	1.50	0.24

Weighted mean natality rate = 0.336 cubs/female/year.

The progressive decrease in Zone F litter size from cubs of the year (1.68 ± 0.06 SE) to yearlings (1.58 ± 0.09 SE) to two-year olds (1.43 ± 0.16 SE) suggests that some mortality occurs during this period, although the decrease was not statistically significant (Schweinsburg et al. 1980). An annual mortality rate of 12.9% was calculated for the entire Zone F population from data for the period 1970-1979.

Utilization

Polar bears in Zone F are hunted by the residents of four communities with a total 1978-79 quota of 108 bears (Table 21). Hunting areas of the various settlements in this zone do not overlap and the kill is fairly well distributed, except for two areas: a) Jones Sound, where the Grise Fiord harvest has been concentrated at least until 1978 (Stirling 1978a); and b) the south Devon coast, which remains untouched (possibly accounting for the relatively high bear densities in that area) (Schweinsburg et al. 1980).

Polar bears are harvested primarily for the commercial value of the hides. The value rose steadily over the three year period, but may not continue to do so indefinitely. In all, eleven sport hunts were conducted from Resolute Bay between 1970 and 1973 for an approximate total revenue of $32,500. The program was suspended for a variety of reasons, including lack of sled dogs, competitive hide prices, negative publicity, and unfavourable weather (which hampered aircraft schedules). As long as high market prices prevail and wage employment is readily available, it is unlikely that Resolute people will be interested in any alternative uses of this species.

Table 21. Summary of polar bear utilization in Zone F, 1976-77 to 1978-79 (Schweinsburg et al. 1980, Smith 1978, 1979).

	Quota				Known kill*			Average hide price paid to hunters in $ (no. of hides)		
Settlement	1976	1977	1978		1976	1977	1978	1976	1977	1978
			Reg. tag	Red tag						
Arctic Bay	12	12	12	4	12	12	13	717(3)	929(7)	1862(4)
Grise Fiord	33	32	33	2	33	33	33	?	?	1401(14)
Pond Inlet	13	15	15	4	15	19	24	855(10)	1081(18)	1155(18)
Resolute Bay	34	34	34	4	33	41	32	247(5)	413(2)	932(22)
Total	92	93	108		93	105	102	$11,936	$26,787	$68,356

* Includes defense and quota kills.

Industrial Activity

Current and proposed industrial projects in Zone F are many and diverse. This area will eventually become a major site for the exploration, production, and transportation of minerals and fossil fuels in the Canadian Arctic. Industrial activities in this zone may be summarized as follows:

a) **Oil and gas**. As of 1979 a total of 7.91 million acres of oil and gas concessions, blanketing the eastern half of Lancaster Sound and adjoining Baffin Bay, were held by three major oil companies (Norlands, Shell, Petro-Canada) (Roots 1980). Parts of those areas have already been subjected to seismic surveys (by ship). Offshore drilling by one company was originally scheduled for 1979 but was deferred by the Canadian Government (Roots 1980). Drilling programs would be conducted by drill ships with marine and aircraft support. Eventual production might entail the use of sea bottom pipelines, sub-sea tunnels, overland pipelines, and tankers. A 10-year development interval is predicted from the time of discovery to production (Roots 1980).

b) **Mining.** As of early 1980, three mineral deposits with commercial potential have been discovered in the region. The Nanisivik lead-zinc mine began producing in 1976 and has a life expectancy of 15 years from known ore reserves (Roots 1980). So far, ore is being stockpiled, but it will eventually be shipped on a seasonal basis. The Mary River iron ore mine is not scheduled for development in the near future. Eventual production would require a marine terminal and year-round shipping via Eclipse Sound and Baffin Bay. The Polaris lead-zinc mine has a life expectancy of 25 years from known reserves. Concentrates would be shipped via Lancaster Sound on a seasonal basis (Roots 1980).

c) **Marine Transportation.** In addition to the aforementioned marine activities, other developments beyond the boundaries of Zone F may have an immense impact on this area through the use of the Northwest Passage. Beaufort Sea oil may be transported along this route by ice breaking carriers. Some North Slope (Alaska) oil may also be taken that way. Liquified natural gas may be shipped south from Bridport Inlet (Melville Island) via the Northwest Passage by ice breaking tankers (Roots 1980).

All such developments require logistical support from the south which would undoubtedly employ marine transportation through the same routes as raw materials were being exported. The high volume of marine traffic in this zone may eventually require Coast Guard surveillance (Roots 1980).

Problems

Zone F will undoubtedly become a region of varied and intense industrial activity. As yet, the impacts of developments such as those in progress or planned for this area are poorly understood in relation to polar bears, and even where problems have been identified elsewhere there are no solutions. Since most hypothetical interactions between polar bears and industry have not been tested, it is impossible to suggest modifications in operating techniques to minimize impact, and also impossible to cope with the industrial disasters that will inevitably occur.* Baseline data for monitoring pollution levels in polar bears are non-existent and each blank year further erodes their "control" value. Although demographic information has been obtained, some unexplained anomalies, such as the low estimated productivity and high estimated population size of Lancaster Sound, will hamper future monitoring programs until they have been clarified.

* On Jan. 12, 1981, Panarctic Oil Co. was charged by the Department of the Environment and the Department of Indian Affairs and Northern Development with dumping petroleum waste into the Arctic Ocean near Little Cornwallis Island (CBC Television Service pers. comm.).

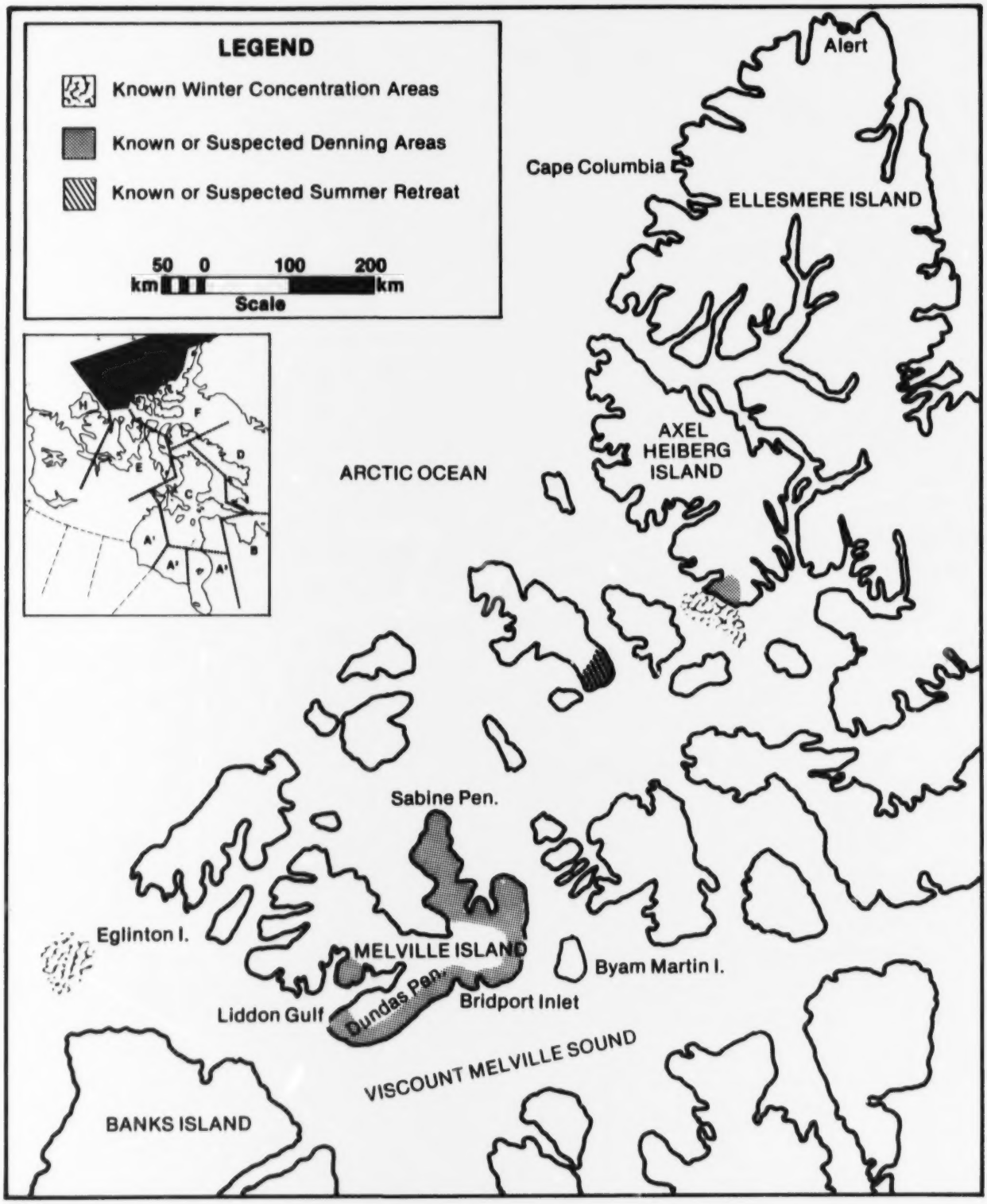


Figure 11. Zone G - Western Queen Elizabeth Islands and northwestern Ellesmere Island.

ZONE G

The waters surrounding the western Queen Elizabeth Islands and northwestern Ellesmere Island are combined in this zone which supports an unknown population of polar bears (Fig. 11). This area lies adjacent to the permanent ice pack of the Arctic Ocean, and consequently marine productivity is low even for polar waters (Stirling et al. 1978). Break-up occurs later than elsewhere in the Canadian Arctic and ice cover may persist between major islands for a number of years. Ocean currents are cold, relatively weak, and their general flow is eastward. The region is far removed from the warming influences of southern currents, and polynyas are probably small if they exist at all.

Population Status

Background

Polar bears in Zone G have never been studied but some incidental observations of bears in the zone have been made (Russel pers. comm., Parker pers. comm., Martin pers. comm.). Also the results of mark-recapture programs in adjacent Zones H (Stirling et al. 1975), E (Schweinsburg et al. 1981) and F (Schweinsburg et al. 1980) provide a few clues concerning the probable status of bears in that region. The climate and ice conditions in Zone G are also relevant to deductions concerning the abundance and distribution of its polar bear population.

Population range

Polar bears and tracks have been sighted in various locations throughout Zone G from Liddon Gulf (Parker pers. comm.) and Dundas Peninsula in the south (Russel pers. comm.) to Alert and Cape Columbia in the north (Land pers. comm.), indicating that this species' range covers the entire zone. It has been suggested that the Zone G population is probably distinct from that of Zone H (Stirling et al. 1975) but the degree of separation is unknown (Schweinsburg et al. 1981). The relationship between bears of Viscount Melville Sound and Melville Island and those of Hadley and Wyniatt Bays is also unknown. Mark-recapture studies in Zone F (Schweinsburg et al. 1980) indicate that bears mix extensively in that region and a few individual movements stopped just short of the Zone G boundary. Most likely there is considerable local interaction between bears of both zones along the southern half of their mutual boundary, since there are no significant physical barriers in that area.

Seasonal distribution

Essentially nothing is known about the seasonal movements of bears in this zone. In the spring of 1974, six or seven bears, including a female with two cubs, were observed in two days. All were moving eastward through Liddon Gulf and it was the impression of the observers that they were migrating (Parker pers. comm.).

Maternity denning

A few family groups were observed in spring in the vicinity of Sabine Peninsula (Russel pers. comm.). Dens were seen on Eglinton and Byam Martin Islands but it was not confirmed that they were maternity dens (Russel pers. comm.). The location and importance of maternity denning areas in Zone G remain undocumented.

Numbers

In general, polar bear densities appear to decline across the arctic archipelago in a northwesterly direction as ice thickness and duration increase (Schweinsburg et al. 1977). Seal numbers in this zone are believed to be lower than in adjacent regions to the south and east (Russel pers. comm., Parker pers. comm., Martin pers. comm.). Thus the density of bears in Zone G is probably lower than in most zones and the total population might not exceed 1000 animals.

Productivity and mortality

Nothing is known about these parameters in Zone G.

Utilization

There is no indication that within recorded history bears were ever hunted by Inuit in Zone G. No doubt a few were killed by polar explorers who crossed, or resided in, the region. Hunting was not allowed in this zone from 1967 until 1973 when a "floating" quota of 12 bears was introduced. That quota may be assigned to any settlement which applies for it and so far has been used by Resolute, Holman Island, Grise Fiord, Sachs Harbour, and Arctic Bay. When more than one application is received, the quota is allotted to the settlement which demonstrates the greatest need.

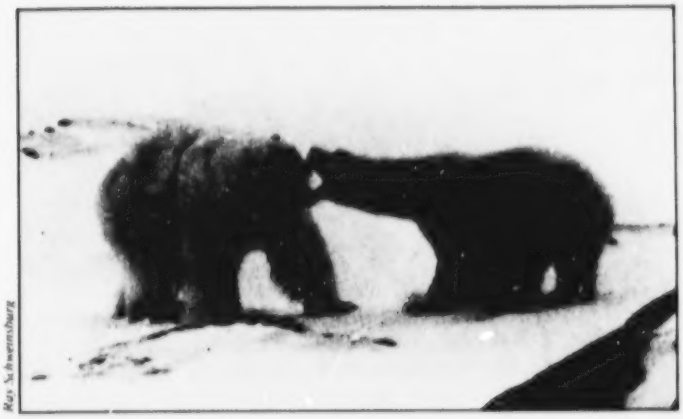
Industrial Activity

A total of 12 offshore wells have been drilled in Zone G between 1973 and 1980. Of those, seven struck gas deposits but none discovered oil (M. Smith pers. comm.). Wells are drilled only during winter by rigs on ice islands. Offshore drilling will likely continue in this zone for some time at current or possibly greater, levels of activity. Docking facilities for ice breaking tankers are prepared for construction at Bridport Inlet, Meiville Island. Proposed tanker routes from there, plus others from Prince of Wales Strait, cross the extreme southeastern portion of Zone G (Roots 1980).

Problems

An obvious problem in this zone is the total lack of data concerning the status of polar bears. This situation could be tolerated indefinitely as long as hunting and defense-kills were kept to a minimum and industrial activities did not increase. However, in view of the apparent hydrocarbon potential of the region, industrial expansion seems inevitable, and if so, an increase in the number of man-bear conflicts may be expected, together with the hazards of pollution and disturbance. As elsewhere, baseline data concerning present levels of industrial contamination in the marine environment (including polar bears) are nonexistent, and related matters such as the identity and toxicity of specific chemicals, the vulnerability of bears to disturbance, and contingency plans for industrial disasters are likewise unavailable.

Another concern in this zone is dissatisfaction with the floating quota system among the settlements involved. The practice of allotting the entire quota to one community based on annual supplications to the Northwest Territories Wildlife Service is deemed unacceptable.



Ray Schweinsburg

"In a place where magnificent wildlife species abound, the polar bear is pre-eminent — as much a lord of the Arctic as the lion is of Africa."

N.W.T. Renewable Resources

Ray Schweinsburg

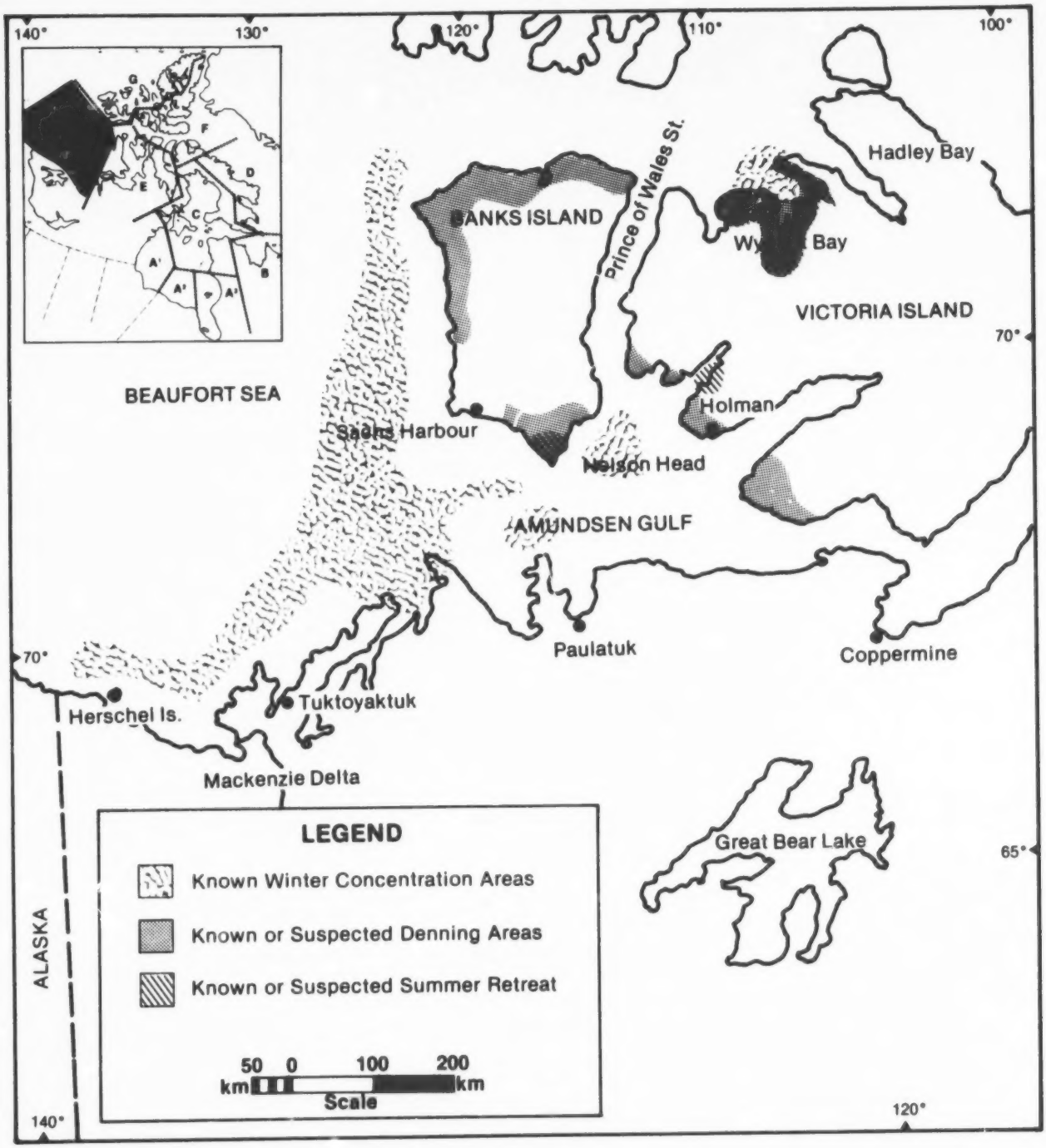


Figure 12. Zone H – Beaufort Sea and Amundsen Gulf.

ZONE H

The Beaufort Sea and Amundsen Gulf plus their surrounding coasts (Banks Island, western Victoria Island, western mainland) are combined in this zone which has been the centre for most polar bear sport hunting in the past and which will become the focus for intensive offshore industrial activity in the future (Fig. 12). The status and ecology of the Zone H population is better known than most in the Canadian Arctic because of the length and variety of studies conducted there.

Ice conditions vary considerably between years in this area. During summer, along the mainland coast, open water may extend up to 250-350 km offshore, but in some years it is confined to a narrow band only a few kilometres wide. In winter, a shore lead polynya system sometimes forms at the western entrance to Amundsen Gulf and from there projects northward along the west coast of Banks Island (Stirling et al. 1975, Stirling 1980). The predominant current in this zone, termed the Beaufort Gyre, is a strong counter-clockwise circulation encompassing the Arctic Ocean from the Mackenzie Delta to Wrangel Island, north to about 85°, and returning along the west coast of Banks Island. A second, weaker current issues from the east channel of the Mackenzie Delta and skirts the west coast of the Tuktoyaktuk Peninsula.

Population Status

Background

Early investigators recorded sightings of bears on Banks Island (Manning and MacPherson 1958) and elsewhere in the Western Arctic (Stefansson 1913, 1921). A preliminary denning survey of Banks Island was conducted in 1963 (Harington 1964). Ecological studies of the polar bears near Barrow, Alaska, began in 1967 (Lentfer 1972, 1974, 1975). Between 1970 and 1977, 528 bears were marked in Zone H (Stirling 1978b) but recoveries were somewhat frustrated by a combination of apathy on the part of some Inuit hunters (failure to report tags or look for tattoos) and inadequate marking devices. Marking continued until 1979 (Stirling pers. comm.). Studies of seal populations (Stirling et al. 1977a) concurrent with bear tagging also contributed to ecological knowledge of polar bears in the zone. Other sources are Wildlife Officer reports and summaries of fur auction results (Smith 1977, 1978, 1979; P. Smith pers. comm.).

Population range

The Zone H polar bear population appears to have little connection with that of Zone G to the north and virtually none with bears of Zone E to the east (Stirling 1978b). To the west, a limited exchange of bears (5-10%) between Canada and Alaska has been estimated, but the actual amount may fluctuate considerably from year to year because of varying ice conditions. Within this zone, bears in the vicinity of the Beaufort Sea may belong to two partially separate sub-populations distinguished chiefly by their disparate summer ranges (Stirling 1978b).

Seasonal distribution

Between freeze-up and break-up, polar bears are distributed throughout the southeastern Beaufort Sea and Amundsen Gulf. During break-up, the annual ice melts and the southern edge of the pack ice withdraws northward. Most bears appear to follow the retreating pack edge; however, ice floes, which remain further south, may locally influence bear movements. Occasionally some bears may spend the summer on southern Banks Island or near the mainland coast (Stirling 1978b). With the onset of freeze-up, bears on the pack ice move south again, presumably to find better hunting areas.

An exception to this general pattern of movement exists at the western entrance to Amundsen Gulf where freeze-up is usually late, and sometimes a polynya is formed that may last all or most of the winter. The prolonged or, in some years, continual presence of open water in this region may be the principal barrier restricting travel between the sub-population of the mainland coast and that of the west coast of Banks Island (Stirling 1978b). Polar bear movements in the vicinity of Prince of Wales Strait and Amundsen Gulf are unknown.

The most important habitats for polar bears in the Western Arctic are active ice and floe edge, as seals are most accessible in such areas. Females with cubs of the year tend to frequent stable, flat, land-fast ice with pressure ridges which are relatively stationary. This habitat affords protection from other bears (which generally avoid it) and is closest to land denning areas, while still providing opportunities to hunt seals (Stirling et al. 1975, Stirling 1978b).

Maternity denning

In general, maternity denning is a broadly distributed activity, occurring usually at low densities due to the large amount of suitable habitat available in the zone (Stirling et al. 1975, Stirling 1978b). A concentration of dens has been recorded in the vicinity of Nelson Head (Banks Island). Elsewhere, evidence of maternity denning has been found along the north and west coasts of Banks Island, on Herschel Island, and to a much lesser extent along the coastal mainland. The fact that comparatively few dens have been located in the latter area may reflect heavy hunting pressure on denning females over the past 80 years by both Inuit and whalers.

Numbers

Population estimates between 1971 and 1977 for Zone H vary from approximately 1200 to 1700 bears. While annual estimates cannot be accurately compared, it is believed that the total population was reduced by about one-third (primarily from emigration) between 1973 and 1975 when the seal population declined 50% during that period (Stirling 1978b) (Table 22). For 1977-78 the total population estimate for Zone H was 2121 ± 960 (DeMaster et al. 1980). However, based on reproductive data for both bears and seals in 1976-77, a conservative hypothetical population of 1435 has been inferred for that year and used since then to determine annual quotas (Stirling 1978b).

Table 22. Some parameters of the Zone H polar bear population, 1971-77 (Stirling 1978b, DeMaster et al 1980).

Year	Population estimate Number	S.D.*	Reproduction: Age class	Reproduction: Litter prod. rate as % of age class	Reproduction: Mean litter size per age class	Survivorship
1971-72	1341	1341	3	7.1	1.50	0.87 ± .02 to 0.92 ± 0.04
			4	0.0	—	
			5	48.6	1.66	
1972-73	1740	868	6-25	29.4	1.70	
1973-74	1755	586	—	—	—	
1974-75	1172	207	3	6.6	1.25	0.86 ± 0.03 to 0.86 ± 0.02
			4	3.8	1.25	
			5	16.6	1.80	
			6-25	17.5	1.57	
1975-76	1575	417	—	—	—	
1976-77	1185	346	3	0.0	—	
			4	14.3	—	
			5	20.0	2.00	
			6-25	33.3	1.57	
1977-78	2121	960				

* One Standard Deviation

Table 23. Summary of polar bear utilization in Zone H, 1976-77 to 1978-79 (Smith 1977, 1978, 1979; P. Smith pers. comm.).

	Quota*				Known kill			Average known hide prices paid to hunters in $ (No. of hides)			No. of Sport hunters (successful)			Outfitting Fee $** (total per yr.)		
Settlement	1976	1977	1978		1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978
			Reg. tag	Red tag												
Coppermine	2	2	2	4	2	0	5	?	0	?	0	0	0	—	—	—
Holman Island	16	16	16	4	14	12	19	643(10)	?	?	4(2)	4(3)	5(3)	4000 (16,000)	4000 (16,000)	10,000 (50,000)
Paulatuk	13	13	13	4	8	2	17	?	?	1566(16)	5(4)	5(0)	0	4000 (20,000)	4000 (20,000)	0 —
Sachs Harbour	18	18	18	4	11	13	22	707(15)	?	?	0	0	0	—	—	—
Tuktoyaktuk	22	22	22	4	21	22	22	881(18)	843(14)	1580(10)	2(1)	1(1)	—	4000 (8000)	4000 (4000)	—
Total	71	71	91		57	49	85	$32,893	$11,802	$40,856	11(7)	10(4)	5(3)	$44,000	$40,000	$50,000

* Yukon quota = 6 bears 1976-79
** excludes all other expenses except cost of outfitting fee and license
? no data
— not successful or not done

Productivity and mortality

The reproductive rate of polar bears in Zone H declined in 1974, following the reduction in seal numbers; however, by 1976-77 it appeared to have nearly regained the 1971-73 level (Table 22). The productivity of ringed seals may also have begun to increase since 1976 (Stirling 1978b). Annual mortality rates for the polar bear population have varied between approximately 8% and 15% between 1970 and 1977 (Stirling 1978b). An average of 12% is employed in most population analyses and modelling projections.

A series of simplistic statistical models, using various combinations of population parameters from Zone H, indicated that selective spring hunting (as opposed to alternatives such as no selection and/or fall hunting) is the most beneficial to bear populations.

Regulations which protect family groups with cubs up to the age of two years might be advantageous if hunting does in fact replace natural mortality. All harvest manipulations hinge on the compensatory abilities of this species in terms of reproduction and survival. Such attributes have not yet been investigated.

Utilization

Polar bears in Zone H are hunted by the residents of five settlements in the Northwest Territories and some Yukon residents on the mainland coast. The locations of these communities prevent hunting areas from overlapping and most bears are taken near the shoreline along the coast on either side of the settlement. The only exception to this pattern in recent years was a special combined polar bear-muskox hunting expedition to Melville Island (Zone G) by Holman Island Inuit in 1980.

Sport hunting has been permitted in this zone since 1970. Recently (1976-79) hunts have been conducted by residents of Paulatuk, Tuktoyaktuk, and Holman Island. The number of communities involved with sport hunting in any one year, and enthusiasm for this use of polar bears, varies with the economic status of each settlement; for example: more lucrative employment may take precedence; the relative commercial value of hides may change (as prices rise the margin of profit between guiding and the fur auction decreases); prevailing opinions concerning the retention of this activity as a strictly cultural pursuit rather than selling the privilege to outsiders can vary over time.

Most bears are hunted for the commercial value of the hide, and occasionally the meat may be used for subsistence. Usually two or three problem bears are shot annually in Zone H, but as many as six have been killed in one year. Frequently defense-kills are taken as part of the quota, but at times may account for extra kills beyond the quota. In the latter instance, hides from such bears are seized by the Northwest Territories Wildlife Service and proceeds from their sale by public auction are returned to the Regional HTA. Meat from those animals is usually donated to the nearest community.

Industrial Activity

Exploration for fossil fuels in the Beaufort Sea began in 1975, followed by offshore drilling in 1976. Both oil and gas deposits were discovered in that year but commercial reserves of oil* were not found until 1979 (Dome Petroleum, Kopanoar Well N13, 12,000 barrels/day) (Ebert pers. comm.).

Exploration activities (seismic, soil sampling) in the Beaufort Sea are chiefly conducted by ship during the summer months. Specially equipped drill ships are also employed during the summer for exploratory wells. Drilling, which proceeds throughout the winter, requires the construction of artificial islands (created from special soil types) or ice islands (where pack ice is relatively stable). Those installations are serviced by tractor train and aircraft (Ebert pers. comm.).

Fossil fuel exploration and production in the Beaufort Sea are expected to increase dramatically in the future, and such activities may become an almost permanent feature of this region, depending on the nature and volume of the hydrocarbon deposits which are ultimately found there.

Problems

The most important polar bear habitats (floe edge, active ice) in this zone are relatively limited in distribution and are overlapped to a large extent by offshore exploration and drilling leases. Oil spills and well blowouts have occurred in the area, and it is inevitable that such disasters will increase, both in number and magnitude, with industrial expansion. Little is known about the effects of such events on polar bears, and even less about how they may be alleviated or rectified. Also, the possibility that 'normal' operations release toxic pollutants, which may be detrimental to bears, has not been investigated.

Man-bear conflicts associated with industrial activities are already a problem in the Beaufort region and no doubt the incidence of such encounters will increase, particularly in the absence of adequate deterrents. Removal of problem bears by the Northwest Territories Wildlife Service has been hampered by lack of manpower, funds, and experienced field staff. The "practical" solution of killing problem bears is not desirable and will become completely untenable if major oil fields are developed.

Annual maternity denning surveys to estimate cub production are not feasible in this zone because of the scattered distribution of such dens, and the difficulty of finding tracks and locating dens because of snow conditions. There is, as yet, no practical method of assessing annual productivity or population size on a regular basis.

* As yet there is no "commercially feasible" technique of producing offshore gas.

GLOSSARY

Concentration area: An ice-based locale (often near land) where bears congregate to feed or breed.

Cub production: The total number of cubs produced, usually by a population. This may be calculated by two methods:

1) av. no. cubs/female/yr. X no. productive females in population
2) (age specific natality rate X no. females in each age class) summed for all age classes.

Defense-kill: A bear killed in defense of human life or property.

Denning area: In general, any location where bears excavate dens. Specific activities such as maternity denning and summer snow denning may occur in "core" areas due to habitat limitations. All known denning areas in Canada are land-based.

Deterrent: Any object or method used to prevent contact between bears and humans or their property, by means of discouragement which does not entail serious injury or death of the animal. Proposed deterrents may be passive (e.g. electric fences, obnoxious odours) or active (e.g. loud noises, bright flares, dogs, stinging darts).

Floe edge: The interface between land-fast annual ice and drifting pack ice.

Land-fast ice: Ice in permanent contact with the sea coast. Usually this ice is first to form in the fall and often last to thaw in spring (or summer).

Man-bear conflicts: Any interaction between bears and humans (or their property) which is deemed undesirable by the latter. Thus, attacks on humans and property destruction both qualify, but hunting does not.

Natality rate: The average number of cubs produced per female per year (or av. cubs/female/year), usually for a certain region or population.

Maximum sustained yield: The greatest number of bears which can safely be removed annually from a population without impairing its productivity. In a broader context this term could refer to the manipulation of multiple uses to derive the most yield for each use category.

Polynya: Any area of water enclosed by ice, wherein the water may be ice free, contain brash ice, and/or be covered with new ice.

Population: Theoretically, all bears belonging to an inter-breeding unit that is usually confined by land barriers, open water, or food resources, and thus separated from other similar groups of bears. In general, the distribution of a population is the sum of the individual home ranges of bears belonging to it, discounting unusual long distance movements by a few bears.

Population modelling: The application of mathematical relationships among various population parameters, with the aid of computer programming, to study the effects on real or hypothetical populations of real or hypothetical circumstances such as harvest manipulations, varying ice conditions, and environmental disasters.

Probability of parturition: The probability that a female bear will have a litter in a certain year. This parameter may be age-specific or overall. It is expressed as a percentage or fraction of females that will have cubs; for example, 0.6 for 10-year old females, or a 60% chance that a 10-year old female will have a litter.

Problem bear: A live polar bear which has attacked a human, destroyed human property, or is a potential threat to either.

Sub-population: Theoretically, a group of inter-breeding bears which has limited exchange (10% or less) with other groups of bears within the same population, and little or no contact with bears outside the population. The distribution of a sub-population is determined by the degree of overlap among the home ranges of the individual animals comprising it. True sub-populations are created by factors which restrict movements, but only to a certain extent (such as impermanent but recurring polynyas, land formations, or hunting pressures). Artificial sub-populations are the result of non-uniform sampling methods which only study portions in a continuum of home ranges. Such sub-population distinctions can be useful for harvest control but not for industrial regulation.

Subsistence kill: A polar bear killed solely for the domestic use of the meat and hide.

Summer retreat: An area of land or land-locked ice which polar bears occupy during the period of minimum sea ice coverage.

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